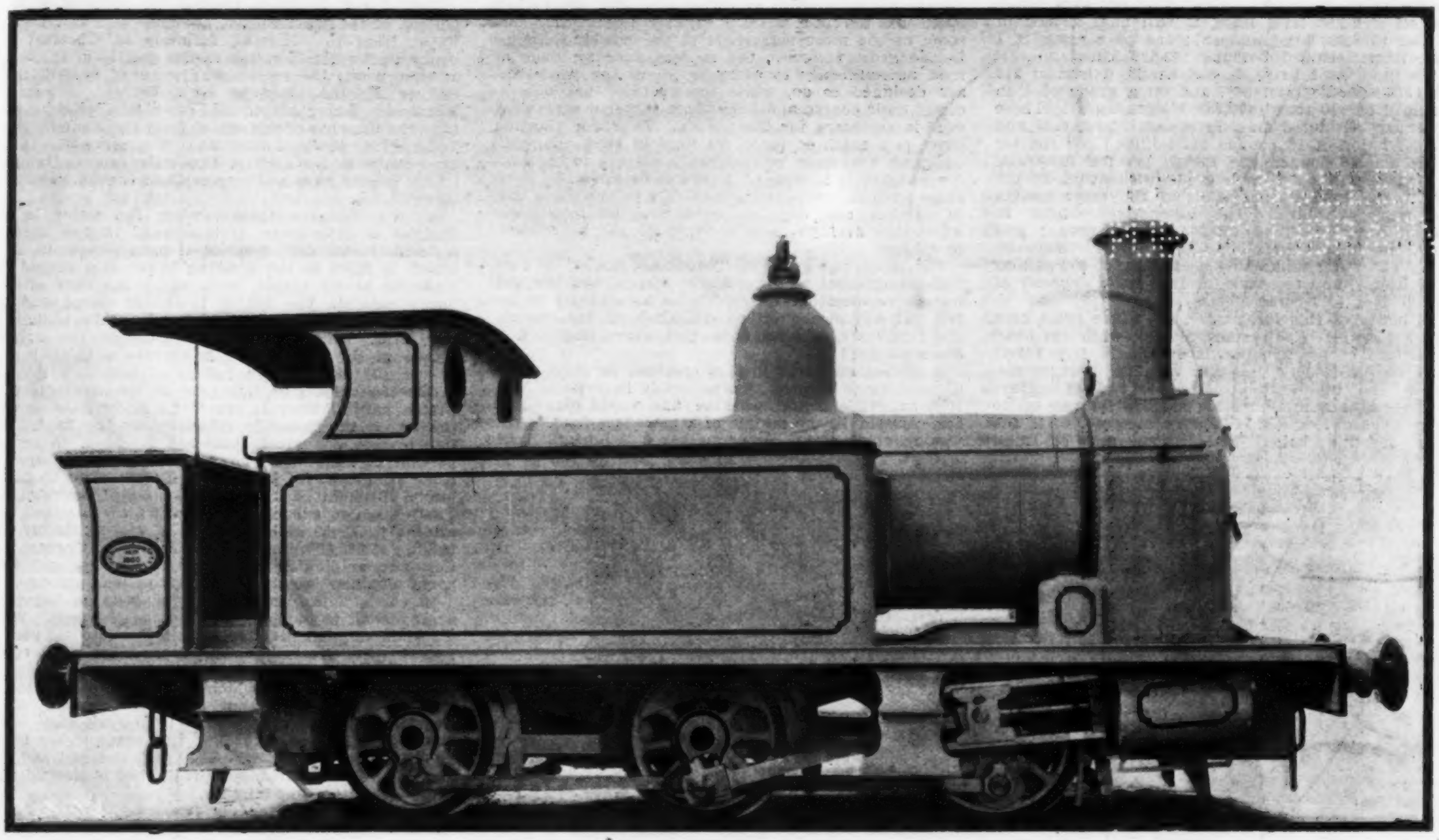
SCIENTIFIC AMERICAN SUPPLEMENT. No 1417

Copyright, 1903, by Munn & Co.

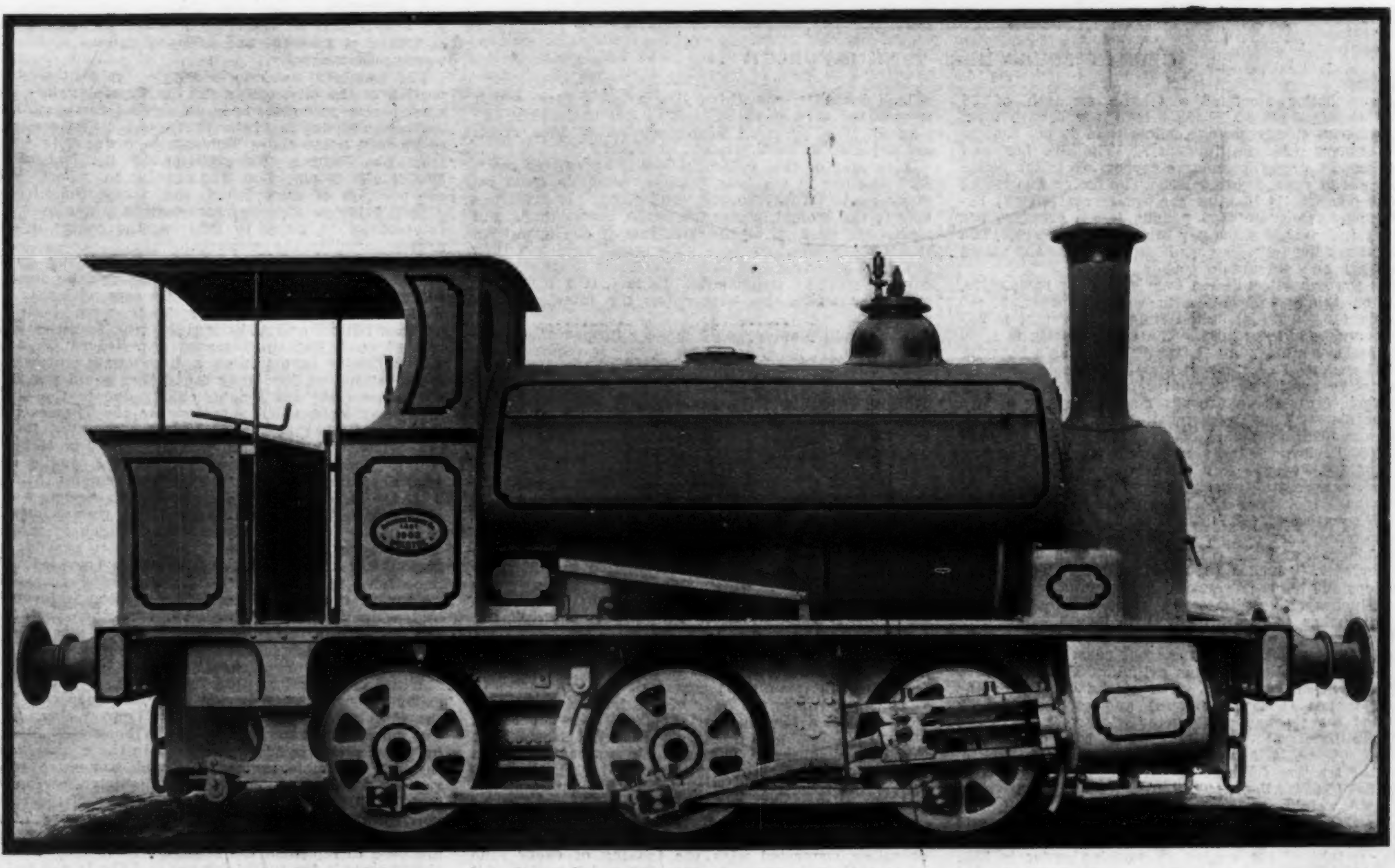
Scientific American, established 1845.
Scientific American Supplement. Vol. LV. No. 1417.

NEW YORK, FEBRUARY 28, 1903.

Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year



"BENGAL" ENGINE: CYLINDERS 18 INCHES IN DIAMETER.



ENGLISH "SADDLE-TANK" LOCOMOTIVE.

ENGLISH AND GERMAN TANK LOCOMOTIVES.

ENGLISH AND GERMAN TANK LOCOMOTIVES.*

By Frank C. Perkins.

The accompanying illustrations on our front page show a six-wheel connected British "Saddle Tank" engine of the "Inglesa" class, and a similar side tank engine of the "Bengal" class, both built by the Avonside Engine Co., of Bristol, England; while the cut on this page shows a German four-wheel connected tender locomotive, built at Kalk, near Cologne, Germany, by the Maschinenbau-Anstalt Humboldt. The six-wheel connected side-tank engine is similar to a four-wheel one, of which the following is the description: The locomotive has a gage of 1 meter, and has cylinders 12 inches (355 millimeters) in diameter. The length of stroke is 18 inches (457 millimeters) and the four connected wheels each have a diameter of 3 feet, 3 inches (990 millimeters), while the total wheel base has a length of 5 feet, 6 inches (1,680 millimeters). This locomotive has a tractive force of 9,000 pounds (4,082 kilogrammes) at 70 per cent cut-off. Exclusive of its own weight, with ordinary conditions on straight level lines, it will haul a load of 550 tons (558,800 kilogrammes); and on a grade of 1 in 40, it will haul 102 tons (103,632 kilogrammes). With a grade of 1 in 40, it will handle a load of 213 tons (216,408 kilogrammes), and on a grade of 1 in 75, a load of 170 tons (172,720 kilogrammes). These figures are calculated on a resistance of internal and rolling friction of 18 pounds (8.15 kilos.) per ton for engine, and 15 pounds (6.8 kilos.) per ton for train. The engine will start on a grade with about 66 per cent of the load it can take up the same incline from a flying start. The locomotive weighs, in working order, 19 tons (19,304 kilogrammes); and empty, the total weight is 15 tons (15,240 kilogrammes). The water tanks have a capacity of 400 gallons (1,816 liters), and the tank for fuel has a capacity of 10 cubic feet (2.2 cubic meters).

The boiler of this locomotive has a fire grate area of 6.8 square feet (.631 square meter), while the heating surface of the fire box is 42 square feet (32.41 square meters). This, together with the heating surface of the tubes—349 square feet (32.41 square meters)—gives a total heating surface for the boiler of 391 square feet (36.31 square meters). All the plates of this boiler and frame are of mild Siemens boiler steel of a tensile strength of 26 to 30 tons (26,416 to 30,480 kilos.) per square inch, and with an elongation of not less than 20 per cent in eight inches (203 millimeters). The fire box and stays are of strong locomotive copper, while the boiler tubes are of solid drawn brass. The boiler was tested to 210 pounds (14.76 kilos per square centimeter) hydraulic pressure, and 160 pounds steam pressure per square inch (11.24 kilos per square centimeter). The tires are of hard weldless steel, and the feed and steam pipes are of solid drawn copper.

The four-wheel connected German tender locomotive, seen on this page, weighs, in working order, 32,460 pounds (19,300 kilos), while empty, its weight is 31,020 pounds (14,100 kilos). The coal capacity is 1,760 pounds (800 kilos), and the water tank has a capacity of 713 gallons (2.7 cubic meters). The boiler of this locomotive has a fire grate area of 8 square feet (.75 square meter), and a fire box heating surface of 39.8 square feet (3.7 square meters). This, taken together with the heating surface of the tubes of 299.6 square feet (29.7 square meters), gives it a total heating surface of 339.5 square feet (33.4 square meters). This boiler operates at a working pressure of 180 pounds per square inch; and the total water heating surface is 395 square feet (36.7 square meters).

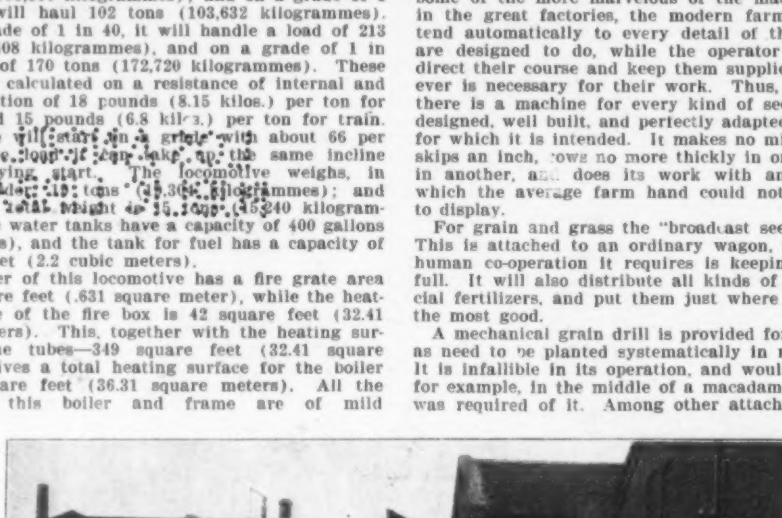
The wheel base of this locomotive is 6½ feet (2,000 millimeters), and the driving wheels each have a diameter of 33½ inches (850 millimeters). The engine develops 100 horse power, and has a cylinder diameter of 11 inches (280 millimeters), while the piston stroke is 16.1 inches (420 millimeters) in length.

The six-wheel connected "Saddle Tank" engine of the "Inglesa" class, shown on the front page, is built for a gage of one meter, and has cylinders 14 inches (355 millimeters) in diameter. The stroke of this engine is 20 inches (508 millimeters) and each of the six coupled wheels has a diameter of 3 feet, 3 inches (990 millimeters). The total wheel base of this engine is 9 feet, 8½ inches (2,959 millimeters), in length, and the tractive force at 70 per cent cut off is 12,200 pounds (5,534 kilos). This locomotive, exclusive of its own weight, under ordinary conditions will haul on level straight lines 785 tons (797,560 kilos), and on a grade of 1 in 40, 143 tons (145,288 kilos). The total weight of the engine in working order is 28¼ tons (28,702 kilos), and it will haul 297 tons (301,752 kilos) up a grade of 1 in 100, and on a grade of 1 in 75, a load of 244 tons (247,904 kilos).

The boiler of this engine has a grate area of 8.2 square feet (.763 square meter), and the fuel tank has a capacity of 2,325 gallons (8.8 cubic meters), while the water tank holds 10,636 gallons, or 2,814 liters of water.

The heating surface of the fire box is 52 square feet (4.83 square meters) and the heating surface of the tubes is 414 square feet (38.45 square meters), making a total of 466 square feet (43.28 square meters) for the entire boiler. These heating surface figures represent only the surface actually exposed to the fire or water, and not the whole area of the fire box and tubes.

* Specially prepared for the Scientific American Supplement.



GERMAN FOUR-WHEEL TANK LOCOMOTIVE.

FARM MACHINES THAT SEEM ALMOST INTELLIGENT.

In some of the latest farm machines the inventors have gone so far as to well-nigh obviate the necessity of human control in connection with the various operations the mechanism is expected to perform. Like some of the more marvelous of the machines in use in the great factories, the modern farming tools attend automatically to every detail of the work they are designed to do, while the operator has only to direct their course and keep them supplied with whatever is necessary for their work. Thus, for planting, there is a machine for every kind of seed, cunningly designed, well built, and perfectly adapted to the work for which it is intended. It makes no mistakes, never skips an inch, sows no more thickly in one place than in another, and does its work with an intelligence which the average farm hand could not be expected to display.

For grain and grass the "broadcast seeder" is used. This is attached to an ordinary wagon, and the only human co-operation it requires is keeping its hopper full. It will also distribute all kinds of dry commercial fertilizers, and put them just where they will do the most good.

A mechanical grain drill is provided for such grains as need to be planted systematically in rows or hills. It is infallible in its operation, and would plant corn, for example, in the middle of a macadam road, if this was required of it. Among other attachments it has a land measure, something like a cyclometer, which records the acreage planted. To cover the seed it has planted, it is provided with a system of hoes which are adjusted to work straight or zigzag.

A variant of this apparatus weeds as well as sows. Still another is the bean planter, which is quite remarkable in its intelligence, so to speak. It drills the hole in the ground, plants the beans, covers them, and marks the position of the next row at one operation. It will even alternate corn with beans, turn and turn about, or plant corn or beans, distribute fertilizer, and cover everything impartially. In fact, it will do anything for which the farmer has the intelligence to adjust it.

The potato planter would make a farmer of a generation ago sit up and rub his eyes. It requires that the potatoes be supplied, but will do all the rest of its own initiative. It picks the potato up and looks it over—or seems to—cuts it into halves, quarters, or any desired number of parts, separates the eyes, and removes the seed ends. It plants whole potatoes or parts thereof as desired, as near together or as far apart as the judgment of the farmer on the driving seat suggests. Having dropped the seed it covers it, fertilizes it, tucks it in like a child put to bed, and paces off the next row with mathematical accuracy.

Certain vegetables, notably tomatoes, cabbages, cauliflower, celery, lettuce, and some others, need to be started in cold frames, and transplanted for the practical business of growing. For this purpose there is a plant-setting machine, which will handle a sprout as if it loved it, establish it in its new environment, gather the earth tenderly about its roots, give it a copious drink of water from a tank it carries, and cover from four to six acres in a day.

The various operations generically known as "cultivating" were once the bane of the farmer's existence. Now he has a machine for each and every operation of crop tending, with a driver's seat as comfortable as that of a buckboard. These machines seem to know a weed from a crop plant intuitively, and while they will snatch the former out by the roots without compunction, they pass the plant unharmed—provided, of course, it is growing in its proper place. These machines have been highly specialized, and for every operation connected with the tending of every kind of crop, there is some one machine which performs it a little better than any other.

When the crop is ready for gathering, mechanism is seen at its best. The perfection of the modern reaper and binder is illustrated by an incident which is said to have occurred this year in Illinois. A farmer had driven his reaper into the edge of a field ready for cutting, and dismounted from his seat to get a drink of cider. While thus occupied the horses took fright and ran away. They tore round and round the field, cutting a full swath with every jump, gathering up the grain, binding it with twine, and tossing the bundles to one side. Before the team was caught it had covered six and a half acres, leaving only patches here and there to be gone over. This was accomplished in something less than twenty-four minutes.—American Exporter.

[Continued from Supplement No. 1416, page 22690.]

THE WATER SUPPLY OF LONDON.—II

By the English Correspondent of the Scientific American.

The Grand Junction waterworks supplies a large portion of the West End of London. It also draws its water from the Thames, formerly at Chelsea; but owing to the deterioration in the quality of the water at that point, the intake was removed several miles farther up the river to Kew Bridge. When the Metropolis Water Act of 1852 came into vogue, forbidding the drawing of any water from the Thames below Teddington, the company had to remove its intake once more, and placed it two miles above Hampton Court, where new and commodious works were constructed.

At the Hampton intake, when the water in the Thames is quite clean, it is allowed to flow through a double intake into a series of open reservoirs, from which it flows to the filtering beds. But should the river be at all turbid, such as is the case after a heavy rainfall, the double intake is closed and the water is received through a third intake higher up the river. The water passes through the screens placed at the intake, and flows into a thick bed of gravel and sand. As a matter of fact, this mixture forms the subsoil at this part of the metropolis, so that a natural filter is provided. After passing over the latter, the water is submitted to the final filtration process, for which there are five beds. A certain portion of the water, however, is pumped direct to Kew Bridge, where it is again filtered prior to distribution through the metropolitan main of the company. There are two subsidence reservoirs at Hampton containing 6,000,000 gallons, and a storage reservoir containing 45,000,000 gallons. The engine plant comprises Cornish pumping engines, rotary engines, and horizontal engines pumping 12,000,000 gallons per day.

In connection with the filtering beds an ingenious arrangement is adopted for cleansing the beds. When a bed is emptied, light steel rails fixed to sleepers of 24-inch gage are laid down. Over these rails travel small trucks with movable skips. The dirty sand is placed in the trucks, which convey it to the side of the bed, where a traveling steam crane picks up the skip, and empties its contents in the washing boxes. Fresh sand is brought back by the crane to the truck, and distributed over the bed, and the railroad dismantled. By this arrangement the bed is cleaned with great expedition and facility.

At Kew Bridge there are two storage reservoirs of 13,500,000 gallons capacity; seven filter beds, covering 8½ acres; and a large pumping installation for pumping the water to the distributing station at Kensington, where there are three covered reservoirs containing 8,000,000 gallons of filtered water, while at Kilburn is another reservoir of 6,000,000 gallons, two at Ealing of 3,000,000 and 5,000,000 gallons of filtered water respectively.

The Lambeth waterworks supply the southwestern portion of the city, embracing the Crystal Palace and surrounding suburbs. It is an ancient company, having been founded in 1785. This was the first company to go to a point above Teddington to draw its water from the Thames, thus anticipating the legislature. The intake is placed at Thames Ditton, where there are a series of sand filters, and a cast-iron pipe of 2 feet, 6 inches diameter conveys the water over the intervening 10 miles to Brixton, the center of the area supplied by the company.

In 1866, owing to the impetus in building operations in the area served by the company, the demand for water exceeded the supply. To cope with this difficulty three subsidence reservoirs were built at Thames Ditton, and additional filtering facilities were carried out. But the company experienced considerable difficulty in obtaining a high quality of water. During times of flood they found they could not filter the water clear and bright, chiefly due to the tributary river Mole, which empties into the Thames near this point. The company thereupon removed its intake four miles higher up the river to West Molesey, where 35 acres of ground were secured, and a new intake constructed. An oval shape conduit 5 feet, 9 inches high by 4 feet, 9 inches width, underground, and four miles in length, was built, connecting the new intake with the Ditton works, which is capable of conveying 20,000,000 gallons of water per day by gravitation. The intake at Molesey is provided with fine gauze screens to arrest floating and suspended matter in the water. By this new step water of a higher quality was obtained, but even then, owing to the turbidity of the river during floods, it was deemed imperative to construct a couple of storage reservoirs. These have a storage capacity of 125,000,000 gallons.

While constructing these reservoirs, a vast underground source of supply was accidently discovered in the deep gravel subsoil overlying London clay. This was pure rain water, and as it is thoroughly filtered by percolation, its flow is directed to the engine wells, through a double series of glazed stoneware pipes varying from 12 to 24 inches in diameter, perforated with small holes, and laid along the sides of the reservoir toward the river. From this source alone 7,000,000 gallons of pure water are obtained every day, and are used to replenish the reservoir when the water in the Thames is too turbid for use and the intake has to be closed.

Brixton is the principal distributing station, and

here there are two covered reservoirs containing 12,000,000 gallons of water, delivered through a 30-inch main from Thames Ditton, aggregating a total supply of 30,000,000 gallons per day. The pumping plant at this station is of a powerful type, since the water has to be lifted 330 feet to supply a reservoir near the Crystal Palace which is 363 feet above the river level. This latter reservoir is of 615,000 gallons capacity, and there is a cast-iron tank of 100,000 gallons capacity elevated on a brickwork structure and covered over.

The Chelsea and the Southwark and Vauxhall waterworks are both smaller companies in comparison with the other metropolitan waterworks. They both draw their supplies from the Thames, the former at Molesey, and the latter at Hampton.

Very different in character from any of the other metropolitan water supply companies is the Kent waterworks; for whereas the former draw their water from a variety of sources, the latter derive theirs entirely from wells. This company supplies nearly the entire southeastern area. Formerly a small volume of water was drawn from the small Ravensbourne River, but this was shortly afterward abandoned.

The wells are sunk down into the chalk, the depth of the borings naturally depending upon the depth of the chalk strata from the surface. The water is clear, bright, and cool. One salient advantage of such a source of supply is that filtering beds are entirely dispensed with, since the chalk is a powerful filtering agent. The water derived from this source is almost free of organic matter, and is of a perfectly blue color when seen in the mass. The wells are distributed throughout the area served by the company. The principal station, however, is at Deptford, where there are a number of wells and reservoirs of 2,000,000 gallons capacity.

One of the disadvantages of water obtained from a chalk source, however, is its extreme hardness. Some years ago a process of softening was devised by Dr. Clark, and was experimented with by the Kent waterworks at their Plumstead station. But the process had to be abandoned, as the apparatus designed to soften the water by means of lime, became choked with precipitated chalk.

Taken on the whole, the provision of London with an adequate water supply did not involve any great engineering triumphs, such as the construction of dams, but there are some magnificent aqueducts for conveying the water from the intakes on the Rivers Thames and Lea to the reservoirs. In the majority of cases the water gravitates from the intake to the reservoirs and filter beds, thus dispensing with pumping machinery.

In the construction of the reservoirs themselves the area selected to contain the water is inclosed with a ballast embankment some 6 feet in width at the top, sloping 3 to 1 on the inside or water surface, and 2 to 1 on the exterior face, as a rule. The earth utilized for this purpose is generally excavated from the inclosed area. In the center of this embankment is built a puddle clay wall, extending from the top, vertically to the London clay beneath, to which it is firmly joined. This puddle clay sets as firmly as a rock, and being of a close, non-porous texture, it renders the reservoir absolutely watertight.

The water before it is passed from the reservoirs into the street mains, with the exception of the Kent waterworks, is subjected to a very severe filtration to free it from any impurities. For many years the test of efficient filtration was considered to be the clearness and limpidity of the filtered effluent. If it was clear and bright when examined through a 2-foot tube, it was considered effectually filtered. But Dr. Koch's discovery of a method of cultivating bacteria, by means of which it is possible to ascertain the number of bacteria in any given sample of water, necessitated the introduction of a bacteriological test.

The water in the Thames and Lea during the winter months becomes very turbid, and is extremely difficult to filter. If at all possible, the companies close their intakes and cease drawing any water, supplying their needs from their storage reservoirs, until the river has become clear again. The turbidity is principally due to the dissolution of various soils, such as clay, chalk, and marl, in the water.

Filtering is accomplished by two processes, generally known as the chemical and the mechanical, and it is the latter which is the most extensively adopted. In this process the water is permitted to percolate slowly through sand or some other similarly porous material, during its passage through which the impurities held in suspension in the water are arrested by the surfaces of the filtering medium. If the water is discolored or contains much organic impurity, Spencer's filtering process, by means of spathose iron ore, or Bischoff's spongy iron is utilized.

In the sand process the water flows from the river or storage reservoir into the filtering basin, which is lined with brickwork or concrete, containing layers of sand and fine and coarse gravel, laid in descending order. Upon the floor of the bed, collecting pipes are laid, which drain off the water, as it descends through the sand, and convey it to the well of the pumping engines, which discharge it into the storage reservoirs, and from the latter it is delivered into the mains ready for consumption.

The thickness of the layers of the filtering materials varies with the different companies, ranging from a series of strata aggregating 8 feet in thickness to 2 feet, 9 inches total thickness. Sand is the most efficacious filtering medium, the layer of which varies from 2 feet to 4 feet, 6 inches in thickness.

The filter beds are periodically cleaned out, owing to the upper surface of the sand becoming choked with aquatic vegetation and silt collected from the water during the percolation, which accumulation impedes the rate of flow into the draining pipes on the bottom of the basin.

The maximum rate of filtration permitted is 540 gallons per square yard of filter bed per 24 hours, or 2½ gallons per square foot per hour. At this speed efficient filtration is accomplished, but the majority of the companies filter considerably below this maximum speed.

The water of the companies is analyzed chemically and bacteriologically by the Local Government Board of the government, and the results of such examinations are published monthly. It is considered that efficient filtration has been secured if the effluent water does not show more than 100 microbes per cubic centimeter after a period of incubation of 48 hours.

The maximum height at which the companies have to deliver water constantly under pressure varies. Zero is decided by the Trinity House high-water mark of the river at Vauxhall and Hammersmith bridges. The various heights are as follows:

West Middlesex, 200 feet above high-water mark at Hammersmith Bridge.

The Kent Company, 180 feet above high-water mark at Vauxhall Bridge.

The Southwark and Vauxhall, 150 feet above high-water mark at Vauxhall Bridge.

The Grand Junction, 150 feet above high-water mark at Vauxhall Bridge.

The Lambeth Company, 150 feet above high-water mark at Vauxhall Bridge.

The Chelsea Company, 148 feet above high-water mark at Vauxhall Bridge.

The New River Company, and the East London Company have to deliver the water 70 feet and 40 feet respectively, above the pavement nearest to point of supply.

Some tremendous extensions are in course of progress with certain of the water companies, owing to the increased strain thrown upon their resources by the rapidly increasing population. The East London are arranging for the construction of several new reservoirs, which, when completed, will have an aggregate capacity exceeding 5,000,000,000 gallons.

BETON FRETTE.

French engineers have for some time taken an active and leading part in the experimental investigations of reinforced concrete and in the application of this compound material to engineering structures. Recently M. Considère, while conducting a series of investigations at the laboratory of L'Ecole des Ponts et Chaussées, was led to believe that the compressive resistance of concrete could be very greatly increased by reinforcement with steel in the form of rings or hoops embedded in the concrete near its surface, when used in the form of columns or similar members of structures. After many and careful experiments upon specimens of considerable size, he has reached certain conclusions upon which he has based rules for guidance in practical design embodying the use of concrete reinforced with hoops or spirals of steel rods or wires, to which he has given the euphonious French name Beton Fretté. The results of his studies have just been published in European journals and the first translation of them published in America is being printed in The Engineering Record. Two portions of the treatise appeared in the preceding issues and other parts will follow in succeeding numbers. Some of the results are so novel and important that we deem it worth the while to call the attention of our readers to these articles.

M. Considère has found that the first forms of reinforcement used for increasing the compressive resistance of concrete, following, as they did, the precedents of reinforcement for tensile stresses by using bars parallel to the direction of the stresses, were insufficient, for such use of the metal simply adds its resistance to the crushing resistance of the concrete without strengthening the latter. Various applications of steel in planes transverse to the stress, in the forms of radial and intersecting rods and netting, likewise did not give as high results as were desirable. Furthermore, it was learned experimentally that the longitudinal rods embedded in concrete which was allowed to set in the air, were subjected to very high initial stresses by the shrinkage of the concrete, sometimes even exceeding the elastic limit of the steel. In the ordinary methods of design these stresses have heretofore commonly been wholly neglected, probably because their existence was either hardly suspected or else their magnitude was greatly underestimated by engineers. That this is not safe practice will be evident after a perusal of the statements given in the article, unless the quantity of material used is uneconomical. Besides, concrete prisms reinforced in this way broke as suddenly and with as little warning, upon attaining their ultimate load, as unreinforced prisms.

The hooped concrete, on the other hand, was found to possess a property comparable to ductility of metals, so that it could endure sharp flexure and severe overloading with evident signs of distress before its final collapse, thus giving a timely warning. This behavior of Beton Fretté makes it reasonable to use a much smaller factor of safety for it than for ordinary masonry or even for other forms of reinforced concrete. Although the elastic limit is capable of considerable change by manipulation, it is well established by the experiments that it is much below the ultimate strength, in which respect this form of reinforced concrete resembles the structural metals.

The very high unit resistances developed by the experimental prisms suggest the possibility of using smaller sections for members built of this material than for those of other kinds of concrete-steel. It is pointed out that connections, as for example between posts and girders, can be very conveniently and efficiently made with this style of construction, involving no weakening of the parts at the joints, as is the case with steel construction requiring holes for rivets or bolts. Columns can be made at once in the desired architectural forms, and need no covering of metal lathing and fireproofing to make them safe and presentable.

Initial application of pressure on hooped concrete raises its elastic limit to that pressure. Therefore the value of the elastic limit is not important for structures made of members subjected to test loads exceeding the working load, and it is proposed to subject such members to a sufficient preliminary pressure before erection. This can be readily and economically done by simple means if the members be manufactured in a shop, and has several manifest advantages.

Steel is manufactured with great care from judiciously selected stock, comparatively high-priced skilled labor being employed. Likewise, the steel shapes are carefully cut, punched, and riveted in shops fully equipped with machinery intelligently designed to accomplish work attaining a high degree of perfection. All of these processes in mill and shop are carried on under surroundings made as favorable as possible and subject to careful superintendence and inspection. Why should not concrete columns, beams, and floor slabs, for example, be similarly made in suitably equipped shops and transported to the structure ready for incorporation in it just as steel work now is? Then the many elements of the fabrication of concrete and concrete-steel, which have been shown by careful experimentation to materially affect the quality of the finished product, could be carefully controlled and thoroughly inspected. Instead of using comparatively unintelligent labor for making concrete of this class as well as of other classes, as is now so generally the case, skilled men could be trained to accomplish uniform and reliable results. This would leave, then, only the connections and similar details to be constructed and inspected in the field under less favorable conditions. It would seem possible to accomplish these parts of the work, however, with the desired degree of perfection, and, besides, they could readily be given such additional strength as needed.—The Engineering Record.

THE THEORY OF WEHNELT INTERRUPTERS.

A very noteworthy discussion of the Wehnelt type of interrupter was brought before the Hungarian Academy of Sciences by E. Klupathy. London Engineering has abstracted the following portions of this discussion:

We have had many experiments and many more or less acceptable explanations of the interrupter. In the Wehnelt interrupter, it will be remembered, two electrodes—a wire anode and a plate cathode—are dipped into sulphuric acid. The current automatically interrupts itself, powerful sparks appear, and the acid becomes hot. The frequency of the interruptions depends, according to the researches of Ruhmer and of Simon, to which Klupathy particularly refers, upon the inductance, the resistance, and the electromotive force of the circuit. Thus each apparatus has its own period; Ruhmer observed, however, that in two interrupters connected in parallel the interruptions take place synchronously, although the natural frequencies of the two apparatus may differ considerably. It is interesting to add, though it has no direct bearing upon the line of argument which Klupathy follows, that Ruhmer also studied the phenomena by means of a kind of Lichtenberg figure device. He covered a brass disk with shellacked paper, and sprinkled lycopodium powder over it. Above the disk, which formed the cathode and which was revolved, he fixed a wire hook as anode; the sparks then caused the powder to accumulate in regular heaps. Simon had explained the steam production in the acid, to which the current interruptions are directly due, by the heat produced by the current in accordance with Joule's law, and he had calculated that heat after the method of Richarz, assuming that the resistance and therefore the heat generation would be maximum at the point of the wire electrode. Klupathy notes, however, that the point is not a material feature of the device at all; it made little difference whether his wire electrodes were pointed or not, and the heat, which, according to Richarz, should be generated under these circumstances at a point, moreover, proved quite insufficient to account for the actual production of steam. Klupathy hence concludes that the heat generation in the Wehnelt cell is not only of the nature of a Joule effect, but, further, of a Peltier effect. Peltier found that when an electric current is sent through the junction of two metals, the one metal will be heated and the other will cool. Bouty, Gill, and others have proved that this applies also to junctions between metals and electrolytes. In the silver voltameter, the passing current heats the cathode, the silver, and cools the anode, the solution of silver nitrate. In the combination platinum-sulphuric acid the opposite occurs—the anode is heated while the cathode is cooled. As a rule the wire is made the anode of a Wehnelt apparatus. At that electrode, therefore, the Joule heat and the Peltier heat will act together, producing a high temperature and causing a strong generation of steam. If the wire is made the cathode, it will be cooled by the Peltier effect, though it will receive its share of the Joule heat. There will further be liberation of hydrogen at the cathode, and a voltaic arc will play between the cool wire and the warm, well conducting acid, provided the current intensity be high; as a result the wire cathode will be liable to fuse. If the currents are not very strong, the wire cathode will not make a good Wehnelt interrupter. Klupathy further observed that the frequency of a wire anode which was not pointed, was increased when the electrode was especially heated by a branch current. As regards condensers and self-induction, he finds that when the condenser is joined in parallel to the interrupter, the frequency will rise if the anode wire is thin and the self-induction small, but will diminish if the wire is thick and the self-induction considerable. In his opinion, the process could then be explained in the following way: The heat produced in the wire electrode evaporates the acid in its immediate neighborhood; the steam generated insulates the electrode, and interrupts the current momentarily; the extra current—to use the old-fashioned term—then strikes through the steam, the spark re-establishes the circuit, and the phenomenon repeats itself. We have assumed the wire to be the anode. If it is made the cathode, the case is different, as already pointed out, and the conductivity of the hydrogen evolved further tends toward leaving the continuity of the current flow undisturbed.

To Clean Gelatin Capsules.—Fill a box of six to eight ounces capacity one-third full of clean, dry salt. In this shake the capsules for a few seconds, then either pick out the capsules or sift the salt through a small sieve. One charge of salt will readily clean up to 300 capsules before requiring renewal.—Drug. Circ. and Chem. Gaz.

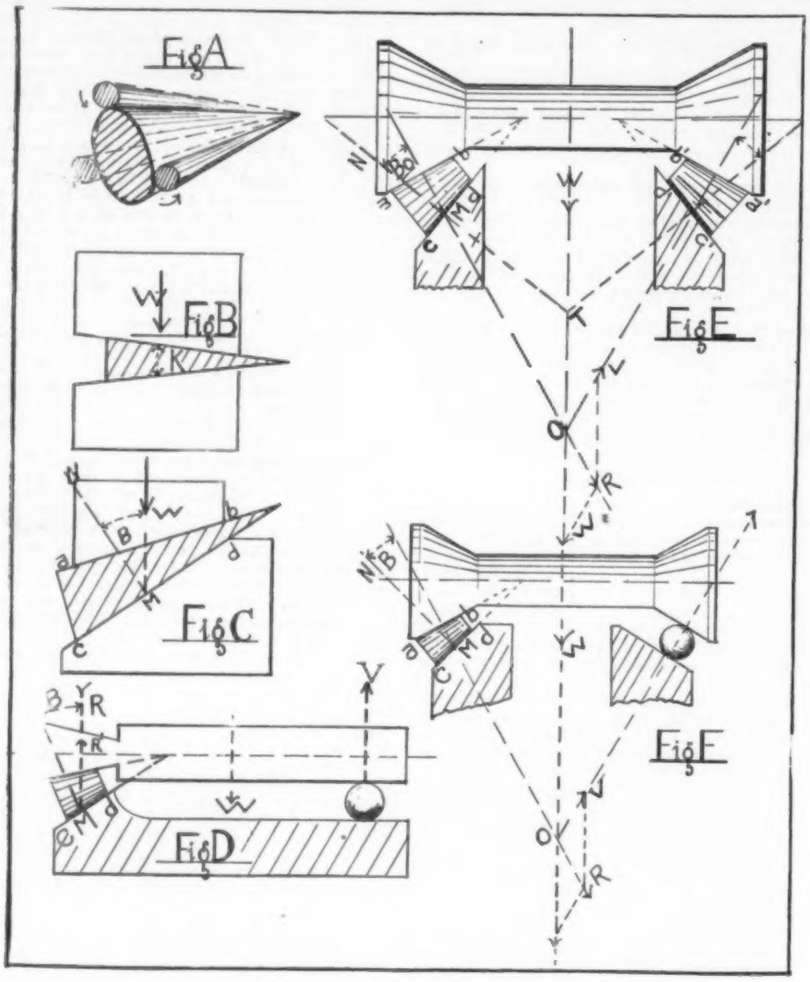
[Concluded from Supplement No. 1416, page 22689.]

ANTI-FRICTION BEARINGS.*

Henry R. Lordly, C. E.

Having heard the inventor's side of the story we will now investigate the theory, by the aid of mechanics, and endeavor to prove whether it is correct or not.

Fig. A represents the inner seat of the Wright



bearing and three cones, in place, the intermediate cones being omitted.

(At the request of a colleague, the following theoretical discussion was prepared by Prof. Church some months ago, as a courtesy to Mr. J. W. Ellis, Cornell, '90.)

"(1) *Rolling Cones.* When one right cone is made to roll upon another of equal slant height, their vertices being first placed in coincidence, it is quite evident that at the end of a complete revolution of the smaller around the larger cone (if the pressure of one upon the other has been just sufficient, and of proper direction to avoid causing slipping) the circles of their bases will still be tangent. In other words, neither cone will have progressed in a direction parallel to the axis of the other. Therefore, in the set of conical rollers in this bearing, there is no

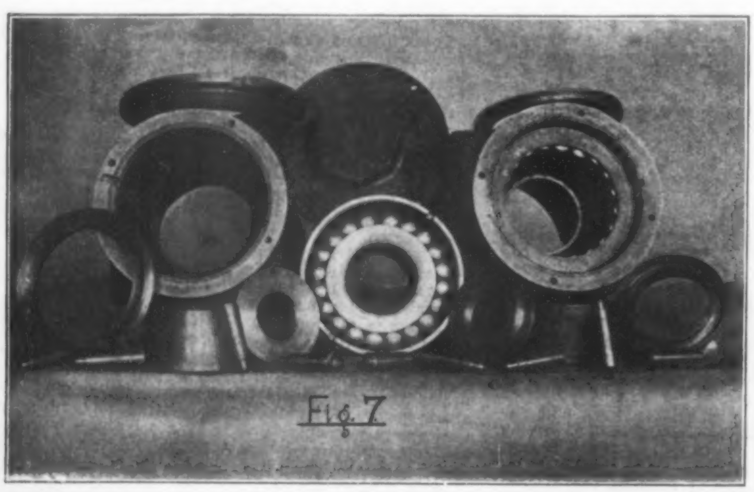
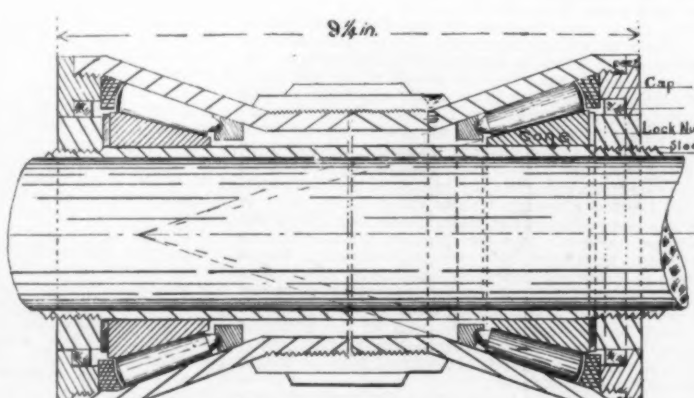


Fig 7



Shafting Bearing
Wright's Patent

Fig 8

tendency to end thrust so far as the geometrical element of perfect rolling is concerned. If the pressure or tendency to pressure between the cones, however, is not properly directed, a traveling of one cone (parallel to the axis of the other) viz., a slipping along the element of contact, may take place, but this is prevented by the outer seat or tread in the mechanical device."

"(2) *Angle of Repose.* Fig. B. ('Reposing Angle?') if a weight, $= W$ pounds, is placed on a wedge or conical roller as in figure, and the angle K of the wedge or sides of the cone has a value greater than a certain critical value (angle of repose known only by experiment, and depending on the nature of the surface contact) the wedge or cone will begin to slip endwise, and if this is prevented by an obstacle, an end thrust is created against the obstacle. While if that angle is less than K no slipping will take place; and if the same obstacle against end thrust is provided, no end thrust is occasioned."

In the foregoing the axis of the cone is considered horizontal.

"Now let it be oblique, as in Fig. C. Here slipping or non-slipping will occur, according as the angle B (MN being drawn normal to the surface cd most inclined from the horizontal) is greater or less than some critical value B (or 'angle of repose') for the bearing surfaces cd. (This supposes that the bearing surface ab is not more slippery than cd.)"

"A convenient way of stating the last relation is that the bearing surface cd is not capable of reacting against the body above it in a line which makes a greater angle than B with the normal MN. If, therefore, the equilibrium of the body above it would require a supporting force or reaction from the bearing cd making a greater angle with $M\ N$ than B, slipping will occur."

"In the above, for simplicity, a single body was to be supported, of weight W, and the cone was the only support. Therefore the force whose angle with MN was to be considered (as to being greater or less than B) was the force W acting in a *vertical* line; the cone itself being considered without weight."

"In the general case, however, we shall have to consider in the place of W the resultant of all the forces acting on the shaft in question aside from the supporting force or reaction which may be expected from the cone. A proper investigation, therefore, of any case requires a knowledge of the mode of support and the forces coming upon the *whole shaft* and not simply those acting on a portion of it."

"For example, consider case of a shaft supported by conical rollers at the left hand extremity and by balls resting between (straight and horizontal) cylindrical surfaces at the other extremity (Fig. D); W being the weight of the shaft and anything carried by it. Here W is vertical and the reaction V furnished by the balls cannot be other than vertical. Consequently the resultant R of W and V must be vertical, and if the shaft is not to move endwise, a force R' opp. and equal to this resultant must be furnished by the bearing surface cd (for if pressure R' were not vertical an endwise motion would occur which W and V being vertical could not prevent). Hence if the vertical line R makes with MN a less angle than B, no end slipping will take place."

"*Second Example.* (Fig. E.) If both ends of the shaft are supported on conical rollers of similar design and symmetrically placed, and if also the vertical line of the weight W is midway between the ends, it follows from symmetry that there will be no end slipping of the shaft and none for the rollers (if their vertices are in the axis of the shaft). In this case, then, the supporting forces or reactions of the bearing surfaces, cd, $c'd'$, will necessarily lie somewhere between two extreme positions, MO, $M'O$, and MT, $M'T$. With this mode of support, therefore, the resultant of W and V would lie somewhere within the angle TMO and is not vertical nor at right angles to the axis of the shaft. (N. B. TM makes an angle $=$ B with the normal to surface ab.)"

"*Third Example.* (Fig. F.) Let the right hand bearing be a ball bearing with parallel conical treads for the shaft and support. The left hand bearing to have the conical rollers in question."

"The line of action of the reaction or supporting force V on the right is completely determined here, being at right angles to the bearing surfaces. The line of W need not be midway between the supports. Prolong the line of W to its intersection with that of V, and join MO. Complete a parallelogram with W as one side and with a diagonal which shall take the line OM as direction, the value of V can be scaled off. The resultant R of W and V makes some angle β with MN, the normal to surface cd. If this angle is smaller than B no slipping will occur along cd."

"(It is here supposed that O comes on the left of MN prolonged. If O should occur on the other side of MN we should then note the angle that OM makes with a normal to ab instead of to cd, to see if it is less than B. In this case the angle with normal to cd would evidently be smaller than that with the normal to ab.)"

"In this example, therefore, the line MO is the line (and not a vertical line) whose angle with the normal to cd it is important to note."

"*Conclusion.* It would seem, therefore, that the exemption from end-thrust characteristic of this bearing (an uncaged free race bearing) employing conical rollers is due:

"*First*, to the geometrical feature that the vertices of the conical rollers lie in the axis of the shaft and coincide with those of the conical treads; and,

"*Secondly*, that the resultant pressure on the bearing in the cases to which the device is applied does not make an angle greater than the critical angle B (or 'angle of repose') with the normal either to the inside or the outside rolling surfaces (treads), or seats."

The reader is requested to return to the patentee's description of this taper bearing and note how completely the patentee's claim coincides with the theoretical investigation.

The author has not found one case in an inventor's claim, for a bearing at least, where the mechanical results so closely approached the theoretical.

Practical tests, however, are after all what proves the worth of any friction reducing device. In this respect the Wright bearing apparently stands pre-eminent and for variety of tests ranks high. Authentic long period tests have been made on street cars, gun carriages, shafting, heavy and light vehicles, the bicycle, and on thrust designs.

Street Car. The first test was made on the Cork Electrical Railway, Cork, Ireland, and clearly demonstrated the ability of the bearing to stand heavy work and to save power.

A test showing exactly the amount of power saved was made on the Montreal, Canada, Street Railway

under the supervision of Mr. J. B. Ingersoll, E. E., and Prof. Owens of McGill College. The following is taken from Mr. Ingersoll's official report dated April 13, 1901:

"Two cars, exactly alike in every respect, were taken and the Standard Peckham journal boxes removed from one car and the Wright roller bearings put in their place. (See photograph of bearing, Fig. 7, and plan of same, Fig. 6.) The car was then loaded with bags of sand and people, equal to forty-two passengers at one hundred and forty pounds per passenger. Each car was equipped with the Thomson-Houston recording wattmeter, furnished by Prof. Owens, of McGill College.

"Leaving Hochelaga shop, the car went east on Notre Dame, north to Letourneaux, west on St. Catherine to Greene Avenue, turning at Greene Avenue and going east on St. Catherine Street to Hochelaga, making fifty-three stops in all and each car stopping at

The (third) test was made with a Wright taper roller bearing. Load: Twenty-five thousand pounds (the full capacity of the crane). The bearing was run for two years, ten hours per day, at 880 revolutions per minute. Result: No sign of wear although made of soft untempered Bessemer steel. These tests were made under the supervision of Mr. C. J. Zacher, Mechanical Engineer, of Buffalo, N. Y.

Shafting Test.—(See Fig. 8.) A severe test made by the author consisted of bolting two 3-inch taper roller bearings on a drill bed about 30 inches apart. Close to one bearing (a) a six hundred pound unbalanced flywheel was attached, the shaft running through, the bearings being about 6 feet long. The pulley was placed at the other end.

By fixing a short piece of belting to pulley and taking one turn about it, and applying weights, it was found that 8 pounds would cause one rotation of pulley. Under the same conditions two plain journals

Fig. 9 is a caged thrust bearing which no doubt saves some power, but the author does not think the principle so good as a free race, uncaged bearing, such as Wright's.

Fig. 10 is one of the latter, the photo showing one face of the two series of rollers. This nest of rollers is keyed on to the shaft and rotates in the box which is below it in the photograph, the box being held by arms. The thrust is against the outer plate against

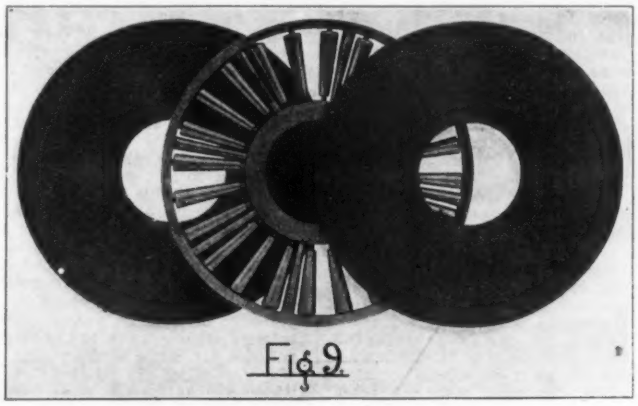


Fig 9

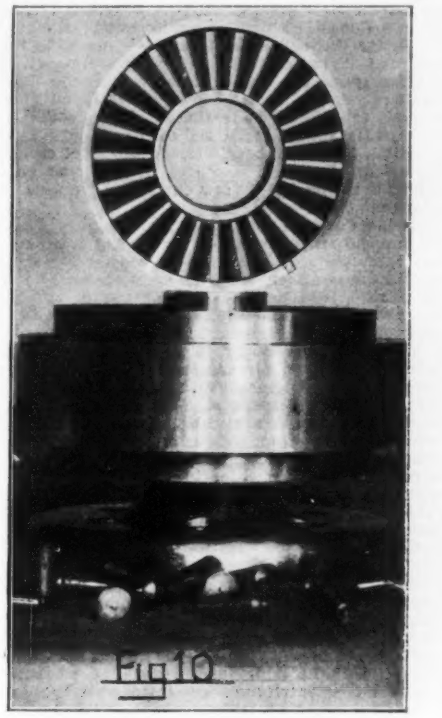


Fig 10

the same point. Total distant traveled by each car ten and six-tenth miles.

"The Standard car consumed 15,200 watts, or 20.37 horse power. The car equipped with the Wright roller bearings consumed 10,120 watts or 13.43 horse power."

If the roller bearing is taken as the "unit of perfection" then the use of the common journal causes a loss over the amount necessary to run the car of about 54 per cent.

Very many interesting deductions can be made from this result, one of the most striking being that considering the larger amount (20.37) as the ratio of the maximum limit of power, then by adopting roller bearings on all cars the number of cars could be increased one-third on the existing power accommodation. Or by equipping two of the old cars with the new bearing the power thus saved would run one new car fitted with a roller bearing. Thus a road with 200 cars could add an additional 100 cars, without increasing power, by the capital expenditure for 300 sets of roller bearings and no additional yearly cost for power. As a business proposition this seems one worthy of investigation.

The vehicle in test 1 had been in daily use, up to April 1, 1902, for eighteen months and the bearings had only been taken off once in the last eighteen months for examination and cleaning. The rollers showed no signs of wear.

The author witnessed a rather interesting test on a small bearing for a buggy. This bearing was held in a grip by the axle and a weight of 200 pounds suspended on the bearing which was speeded up to 1,000 revolutions per minute. This test was continued for 6 hours, at the end of which time the bearing was perfectly cool. It ran smooth and without noise.

RESULTS OF TRACTION TESTS ON WRIGHT'S TAPER ROLLER BEARING.

No.	Style of Vehicle.	Load on Axles.	Pull necessary to start Vehicle. Common Bearing.	Roller Bearing.	Remarks.
					Weight of load only.
1	Freight wagon.....	1500 lbs.	37 lbs.	12 lbs.	
2	Gun carriage.. ..	967 "	55 "	15 "	2 wheels.
3	Freight wagon.....	H'y loa	107 "	49 "	
4	Bullion van........	3 tons	....	Drawn by one horse	
4a	Bullion van........	2 "	Drawn by one horse..	....	Van with roller bearing took one-half more load than this wagon.
5	Freight wagon....	3000 lbs.	107 lbs.	40 lbs.	Total load on axis.
6	Freight wagon.....	Heavy	216 "	112 "	
7	Omnibus......	3200 lbs. empty	113 "	44 "	
8	Omnibus.........	With 20 people	205 "	89 "	Test taken after vehicle had been in daily use for 8 months and traveled 4000 miles.

Traveling Crane Test.—This comes next in importance, as a test in heavy work, and particularly so because various styles of bearings were tried. The crane in question was so constructed that a certain portion of its gear was running all the time when the engine was in motion.

The (first) test was with an ordinary bearing (steel) and a load of nine thousand pounds applied. Speed of bearing 880 revolutions per minute. Result: Bearing welded together.

The (second) test made with a three ply ball bearing. Load, thirteen thousand pounds. Result: Balls crushed, and bearing ruined.

were tried, the shaft though being of a smaller diameter. In this case it took 14 pounds to cause one rotation of pulley, including the attached shaft and fly wheel.

When speed was applied, 160 revolutions per minute, in the first place, it was found that the casing of the taper bearing W nearest the fly wheel moved in the clamps, and a slight heating occurred, but the bearing near the pulley, which was firm, remained perfectly cool.

This test was witnessed by Mr. George Harvey, M. E. An application of the formulæ for loss of work due to friction, after determining the coefficient of friction by the above experiment, did not show more than a small percentage of saving for the taper bearing, but it was considered that this was due to imperfections in the test, different size of shaft, imperfectly adjusted bearings, loss of power in shafting, etc.

Loss of Power in Shafting.—A few words on the amount of power expended in turning shafting would not be out of place here. After an extended investigation on this point the author failed to find any cases where the loss in this respect reached what some text books place it at. There are some cases where it might reach 70 per cent of the total power used, but as one factory manager put it: "Such cases should not be considered as examples of engineering."

The writer found one case as low as twenty per cent, but this was in an exceedingly well managed factory. The total amount of horse power being about 350.

The majority of plants use from 33 to 40 and sometimes 50 per cent of the total power to turn the shafting, but when this latter amount is reached or exceeded, the reason should be sought for. The fact

which the rollers revolve, or there may be a pull inward which brings the side of the bearing shown against its face, when the shaft presses to the left, and on the inner seat for the rollers. The actual bearing from which this photograph was taken was made for a 3,000 H. P. waterwheel, and was tested by the author.

The real size of the rollers here is 1¾ inches and the thrust to which the bearing was subjected was quite heavy. The speed of the shaft was 186 and therefore the speed of each roller was over 1,400 per minute.

The first trial showed some heating in the rollers due to the seat not being in perfect vertical alignment and one roller was not properly tempered, but the bearing, on the whole, acted well.

The turntable bearing is constructed on the plan of the series of rollers in Fig. 10, and accomplishes wonderful results. For a locomotive turntable, fourteen rollers, four inches long and three inches diameter at large end, are sufficient.

A glance at Fig. 11 will complete our review: This is a free race, uncaged, taper bearing on Wright's principle, designed for bicycle use. The bearing from which this photograph was taken besides having been tested in actual use, has, to the author's knowledge, run over fifty thousand miles in a high speed testing machine. An examination of the rollers will show that the tool marks are still present, thus proving

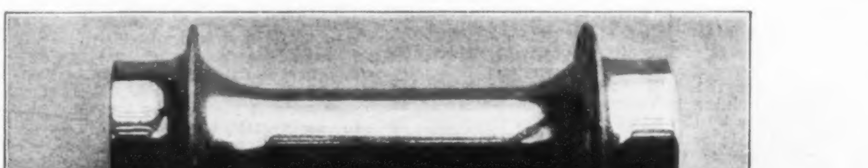


Fig 11

is in very many plants, and plants managed by men of ability, too, the actual loss due to friction in shafting is an unknown quantity.

Thrust Bearing.—Thrust bearings, turntable bearings and step bearings are mechanically about the same, and the field is sufficiently large for a good device for this work.

that they have not worn after the long and severe test. It is stated that this style of bearing is now being manufactured in the United States at Buffalo, N. Y. Many perhaps will doubt its superiority to the bicycle ball bearing, but the writer's experience goes to show that it is better.

The author has found the experience gained in ex-

amining and testing these various bearings a valuable and interesting one, and the data herewith presented is but a small portion of that obtained. He trusts that many will find what has been presented of value.

IMPROVEMENTS IN SUGAR-REFINING DURING THE LAST TWENTY-FIVE YEARS.*

By T. L. PATTERSON, F. I. C., F. C. S.

SUGAR-REFINING is a physical and mechanical, rather than a chemical process. Briefly stated, it consists in the dissolution of raw sugar in water; filtration of the liquor through cloth to remove insoluble impurities, and through animal charcoal to remove color; and finally, concentration of the decolorized liquor to obtain crystals. But it depends largely on chemical analysis for the determination of the composition and value of the raw material and for checking the various processes in the refinery. Hence the staff of no well organized refinery is complete without one or more chemists, although very few chemicals are used in the process itself.

On the Continent, chemical processes are wholly in use for the removal of coloring and nitrogenous matters from beetroot juice. These consist for the most part in the treatment of the juice with alkaline earthy bases, zinc, iron, and tin salts; carbonic, sulphurous, and hydrosulphurous acids. Electricity, too, is on its trial for the same purpose and for the partial removal of mineral salts. Some of these chemical processes have been adopted for the treatment of cane-juice in the colonies, but none have been introduced into this country, except perhaps in a very modified way, because they are not applicable to British methods of refining. Sucrose undergoes inversion and decomposition so easily, and is so closely related in composition to some of the impurities to be removed, that treatment with strong chemicals is out of the question. For this reason animal-charcoal still maintains its position as a decolorant in the production of the highest class products, as well on the Continent as in this country.

No revolutionary change has taken place in the refining industry during the last twenty-five years, but many improvements on the old physical and mechanical processes have been made and introduced. The first of these to which I am about to direct your attention consists in improved methods of washing raw sugar in the centrifugal, just introduced by Weinrich prior to this period, with steam, or with hot or cold water. The process was afterward improved by Duncan and Newlands, Walker and Patterson, and others. Theoretically, raw sugar may be said to consist of pure sugar crystals and molasses. The object of the process is therefore to wash out the molasses, and raise the standard of the raw material—chiefly beetroot sugar of low quality—to that of the higher grades, and make them suitable for the production of the highest quality of refined sugar. For this purpose raw beetroot sugar of 75 per cent to 80 per cent net analysis is filled dry into the centrifugal, or mixed with syrup or water, and transferred to a centrifugal machine. After spinning out the syrup added or made, the sugar in the machine is washed with water or steam until most of the molasses is removed. The product which still contains all the insoluble impurity and some of the coloring matter has been raised in quality, though reduced in weight, to an analysis of 90 per cent to 95 per cent net. The process separates the raw sugar into two products, viz., (*a*) the partially purified or washed crystals, which are submitted to the ordinary process of refining for the production of white crystals, cubes, or granulated; and (*b*) the washings, containing the molasses which go to make yellows and syrups.

In the filtration of sugar liquors, filter-presses have been introduced with marked advantage, but in most refineries the old Taylor filter, with in some cases trifling modifications, still holds its own. There is room, however, for a greater use being made of the filter-press than has yet been done. Sometimes when filtration is difficult, a precipitate of phosphate of lime is brought about in the solution which coagulates gummy and gelatinous matters; or sand, kieselguhr, or other inert matter is added, to prevent them from choking the pores of the filter cloth, and thus facilitate filtration.

Animal charcoal is still the chief or only decolorant used in the refining industry. It is supplemented in many refineries by the addition of sulphurous acid in the gaseous state or in solution to the filtered liquid. The acid bleaches the yellowish liquors from the charcoal to a considerable extent, and any excess is expelled in the after process of concentration. With the exception of phosphoric acid solutions, carbonate of lime, lime, and sulphuric acid for syrup inversion, sulphurous acid is the only chemical now in use.

The process of concentrating and graining the sugar solutions—technically called boiling—is always conducted in vacuum pans which boil at a low temperature. No improvement worthy of remark has taken place in the apparatus itself. But improved evaporators have been introduced by Yaryan (1886) and Lillie (1888) in America for the concentration of cane-juice, char, and other sweet waters, which have found their way into the refining industry of this country. They are built either vertical or horizontal, on the multiple effect system so largely used on the Continent and in the colonies. They consist of one or more vessels divided into three compartments. The central or heating chamber is filled with pipes which connect the feeding chamber at one end with the collecting chamber at the other. Thin liquor is supplied in a regulated flow to the feeding chamber, where it is distributed in films over the inner surface of the pipes heated by low-pressure steam, and thence into the collecting chamber more or less concentrated. The vapor evaporated from the liquid is conveyed to the heating and the partially concentrated liquor to the feeding chamber of the next vessel, and so on for as many vessels as are in series, usually three. A good vacuum is maintained in the last vessel and the manipulation is the same as that in use with the old triple effect. The advantage of these evaporators is attributed to the great economy of heat, the small quantity of liquid submitted to heat at one time, and to the rapidity of evaporation. The liquid is only in the apparatus a few minutes before it is discharged concentrated to the desired density. During this time cane juice at 14 deg. Brix can be raised to 51 deg. Brix, and water equal to 72 per cent of the weight of the juice evaporated.

While no great advancement has taken place in the construction of the vacuum pans in which sugars are grained, improvements have been made on the condensers, so that now two or more pans are worked in connection with one condenser. And in order to economize water, the condensers are made counter-current, that is to say, the water flows in the opposite direction to that of the vapor.

Some progress has been made in the method of boiling crystals on the lines of a "seeding" process introduced by Lebaudy of Paris some time prior to the commencement of the period under review (1865). This process has grown in favor and been largely adopted in the refining industry. To make the advantage of this improvement plain, it will be necessary in as few words as possible to describe the process of boiling. Large and well crystallized sugars, other things being equal, bring a better price on the market than small badly crystallized goods. Hence in boiling white sugars, except where granulated and cubes are required, the object of the refiner is to produce as large crystals as possible. With this end in view, it used to be necessary to start the pan with nearly pure sugar solutions, and when full of masse-cuite—that is a magma of sugar crystals and syrup or mother liquor—the pan was "cut" as it is technically called, that is half emptied, and the boiling process started again by feeding in more liquor. The crystals left in the pan grew larger with every increment of sugar solution, the motion of the boiling mass, and rapid concentration, until the pan was again full, when it was again cut. This process of cutting had to be repeated several times until the crystals attained the desired size, when the pan was completely emptied. Practically it is not possible to go on cutting indefinitely, because the boiling requires to be slowed down as the crystals increase in size, and the process would have to be greatly prolonged, making it very difficult to prevent the formation of new small crystals which must be sifted out, and injuring the color of the syrup from which the after products are boiled. In this way several lots of sugar are obtained, the crystals of which increase in size from the first cut to the last. As all are of the same quality, though differing in size of grain, the refiner's aim is to turn out each lot with large well-formed crystals, which command the highest price.

To obtain this result, reduce the cutting and shorten the time of boiling, refiners now proceed as follows, viz., they concentrate some liquor in the pan to nearly the crystallizing point and add to it a proportion of the dried sugar from the first or earlier cuts of a former boiling. The operation is technically called "seeding" the pan. The added crystals or "seed" grow as boiling proceeds, and attain full size much sooner than they can do under normal conditions. A refinement of this operation consists in using foreign sugar crystals as seed and growing the sugar in the liquor on them. When the different pans from this method of work are mixed, all the crystallized products can be turned out of large and uniform quality.

With the same object in view, when two pans stand together, it is a common practice to connect them with a pipe closed with valves. One pan is boiled full of masse-cuite, which may be started from liquor alone or from liquor and seed, the connection between them is opened and the second pan partially filled from the first. Boiling then proceeds until both are full and ready to cut, or be emptied, as the size of the grain warrants. No improvement has taken place in the boiling of mediums and yellows.

The masse-cuites are dropped from the pans into mixers, whence they are delivered to the centrifugal machines in which the syrup is separated from the sugar. The sugar is more or less washed, discharged into bins, air-dried, and filled into bags for market. Hitherto the syrup and washings have been collected together, and a second quality of sugar crystals boiled from the mixture. In the process of washing, rendered necessary to remove the mother syrup which adheres to the crystals, a considerable proportion of the sugar is dissolved and lost to the first product. This has always been a difficulty which refiners try to obviate by using as little water as possible, and carefully regulating that used to the class of sugar washed. But notwithstanding every care, 6 per cent to 15 per cent of the first products are washed into the second products, for which a lower price is obtained. A recent patent of my own (1897) has made it possible to separate in the centrifugal itself the washings from the syrup or mother liquor, so that washing may now be practised with impunity. The washings, having the same purity as the liquor from which the sugar was boiled, are returned to the pan separately from the syrup and boiled up with liquor to produce first product sugar. In this way the loss from washing has been avoided. Several large refiners are presently erecting machines to work this process and good results are anticipated.

In describing the process of boiling crystals we excluded "granulated" and "cubes." Both are practically products of the last twenty-five years. No seed is used for either of these sugars as only small crystals are required. The masse-cuite for granulated sugar is treated in the centrifugal to separate the syrup; after washing the moist sugar is completely dried in a Hersey, Newhall, or Gibb revolving cylinder through which a current of hot air passes. It is then cooled and packed for sale.

There are many patent processes for making cube sugar. Those which have been worked in this country are the Langen, Duncan and Newlands, Walker and Patterson, and the Adant. All are manipulated in much the same way. Masse-cuite boiled to a small grain is filled into molds divided by partitions, so that the spaces between may form, when full, plates or prisms of sugar about five-eighths of an inch thick. The molds are either a kind of centrifugal basket, or made to fit neatly into centrifugal baskets. The masse-cuite is allowed to set and cool in the mold, when the crystals become cemented together by a secondary crystallization which takes place during the cooling process. The cooled molds are then placed on a centrifugal spindle or in a centrifugal basket, and the syrup spun out. While spinning the sugar plates are washed with clairce—a saturated solution of pure sugar in water—and when this too is spun out the molds are removed and taken asunder. The plates are carefully separated and placed in a continuous mechanical or other stove, where they are dried in a current of hot air. The dry plates or prisms, now so hard that they have a metallic ring, are then transferred to a special cutting machine which chops them into cubes for market.

Besides the molded masse-cuite processes just described, there are several others in which a kind of artificial masse-cuite is produced by mixing crystals, or crushed sugar, with a hot saturated solution of sugar. This mixture is then molded into plates or prisms. Or again the sugar is moistened with water and pressed into molds to form cubes or tablets, which are dried in the usual manner. None of these processes yield such a first-rate product as cubes made directly from masse-cuite, and need not be further referred to. The cube is such a convenient form of dry hard sugar, and its manufacture is now so perfect, that it has entirely supplanted the old form of loaf sugar in this country, the cutting of which was a most disagreeable household experience. Loaves are still made on the Continent, but their manufacture is rapidly dying out.

Passing to the residual products of the refinery we will consider an improved method of treating molasses, which in the beetroot sugar industry, because of the presence of a large percentage of lime and alkaline salts of organic acids, is the refuse of the process only suitable for cattle feeding and distilling. It is called "Crystallization in Motion," many modifications of which are at work. The process was introduced on the Continent about twenty years ago, for granulating out the last available sugar that will crystallize. Patents were granted to Bock, Huck, and others, the latest improvement being perhaps that of Grossé. The apparatus consists of large cylinders or tanks, provided with a stirring arrangement kept in very slow motion, and in most cases surrounded by a jacket in which hot water circulates to control the cooling. It is often fitted with an air-tight door and connected to the vacuum pump and air pump by pipes, that it may work under reduced pressure and be emptied by increased pressure when finished.

The low syrups or molasses are put into this apparatus after they have been boiled to the granulating point, when they are in a supersaturated condition. Stirring then commences and is repeated at intervals during 50 or 60 hours, while the contents cool down very slowly to about 50 deg. C. controlled by the hot water jacket. Under this treatment the small crystals of sugar at first formed grow in the viscous mother liquid or molasses, and become large enough to be easily separated from the exhausted molasses in the centrifugal machine.

The process of crystallization in motion is an interesting one because it overcomes a practical difficulty in a very simple way. It may be explained by considering what takes place when partially exhausted, concentrated molasses is slowly cooled at rest. Such molasses is a thick viscous supersaturated liquid, in which the free sugar molecules are held apart by the large proportion of organic salts and other organic bodies present in solution, and in which that freedom of molecular movement favorable to the formation of large crystals is entirely absent. Practically crystallization proceeds continuously as the solution cools, but theoretically, it is intermittent, and we can assume that several free molecules arrange themselves around another molecule in innumerable centers in the mass, to form small crystals. After withdrawing the free molecules in their immediate neighborhood, crystallization stops at these centers, and the crystals formed drop to the bottom of the cooler, or remain suspended out of the sphere of action. As cooling proceeds the solution again becomes supersaturated at the lower temperature, and new crystals form in new centers, to drop out of action as before. In this way supersaturation and crystallization proceed together in different centers, and succeed each other, until the mass is cool, with the result that most of the sugar is crystallized in a very fine state of division, the greater part of which passes through the perforated linings of the centrifugals along with the molasses, and cannot be recovered. The motion of the mass under the influence of very slow cooling overcomes the difficulty of the formation of small crystals and prevents the mother syrup from reaching a supersaturated condition. The crystals first formed are transferred to new spheres of action, and the free molecules arrange themselves on the crystals already formed in preference to forming new ones. Thus the crystals grow as the mass cools and the final product is a crop of crystals large enough to be easily separated from the exhausted molasses in the centrifugal machine. When the molasses contain very little sugar, as they often do, to yield a fair crop in this way, the masse is seeded with a proportion of crystals from a previous boiling to form crystallizing centers, and all the sugar that will crystallize is recovered. On the other hand, when the masse is too thick and viscous, a little thinner molasses is added to give that freedom of motion required. Usually the molasses from this process go to the distillery, or for cattle feeding. But as nearly all the syrups in this country are refined and go into consumption as golden syrup, the process has only been adopted by one or two refiners.

The manufacture of golden syrup has greatly increased during the last quarter of a century. The quality has been very much improved by the use of high-class syrups and sugars as the raw material from which it is made. On the other hand, it has been much impaired by the use in large quantity of liquid Indian cornglucose for diluting poor syrups, improving the color and preventing granulation. Good, well

* Paper read before the Society of Chemical Industry.

inverted syrups do not require this addition, nor is it practised by the best makers.

The syrups and sugars used for making golden syrup require to be partially inverted to prevent the granulation of cane sugar in the finished product. For this purpose they are heated with a little sulphuric acid, which is afterward neutralized with carbonate of lime and the sulphate of lime filtered out. The liquor is then passed through charcoal and boiled to the required density. Some refiners use yeast instead of sulphuric acid, according to Tompson's 1884 patent more or less modified. The action is slower than with acid, but it enables them to work without chemicals. Yeast added to strong solutions of sugar and heated to 50 deg. to 70 deg. C. does not set up alcoholic fermentation. An objection to yeast is the introduction of organic impurities into the syrup which are not removed by charcoal.

White sugar is made on the Continent direct from beetroot juice by the chemical agents already referred to, without the use of charcoal. Many of the refineries, too, work without charcoal, but the products are never so pure and white as they are when this decolorant is employed. The best results and finest products can only be obtained with charcoal. Consequently in this country, where the public demand the best of everything, all refiners use char. As large quantities are required, at least one ton for a ton of sugar, it may be taken for granted that the char department is the largest and most expensive in a refinery. Any useful improvement introduced into this department will therefore be of value. And progress has to be recorded here as elsewhere in a refinery. It is chiefly mechanical, and consists of improved methods of handling the char. Formerly the char, wet from the filters, was delivered by hand to kilns with fixed burning pipes, drawn by hand from the coolers below into barrows and wheeled to elevators, often after having been spread on a cooling floor by hand, because the kiln coolers were too short to do their work.

Now, the wet char is delivered mechanically on to kilns in which the reburning pipes do or do not revolve. In its passage down the pipes the char is raised to a low red heat, which destroys the organic matter absorbed from the sugar. Below the kilns it enters ample coolers which are a continuation of the burning pipes, whence it is automatically discharged into receivers ready for use. Then, as it is required, endless bands carry it from the receiver to the elevator. Thus the char is almost altogether mechanically handled; little or no labor is needed from the time it leaves the filter till it returns to it, except that required to control the machinery, and distribute the char on the kiln-heads and filters.

Char kilns have been greatly improved by placing driers on the top heated by waste gases from the kiln fires, an adaptation introduced from American practice. Wet char passing through these is delivered into pipes dry. Thus, the driers do outside what was formerly done inside the pipe, and make it possible for each kiln to reburn the maximum amount of char.

Char is the great sugar refiner and much care is bestowed on its manipulation. With repeated revivification, even in the best kilns, it gradually loses its decolorizing power, and after a year or two's use has to be turned out. The cost of renewing it is a serious item in the upkeep of a refinery. Two causes are chiefly responsible for the deterioration. One of these is the reduction of porosity brought about by the shrinkage of the calcium phosphate during successive reburnings. The other is due to the deposition of vegetable carbon, which has no decolorizing power, on its surface and in its pores, by the carbonization of organic matter absorbed from the sugar. No remedy has yet been found for the former evil; but it has long been recognized that, were it possible to remove the vegetable carbon the latter would be taken away, the decolorizing power would be greatly improved and the life of the char prolonged. This is the problem refiners are now trying to solve, and already two or three apparatus are on trial in which char is burned in a limited supply of air. Chief among these is a cylinder with revolving paddles patented by Weinrich in 1896. It is in use in two or three refineries and good results are said to be got from the process. The patentee claims that impurities are oxidized at a temperature of 300 to 400 deg. F. when this apparatus is used instead of ordinary kilns, but that a temperature of 600 deg. F. is required when it is used as an auxiliary to these kilns. About the same time I was independently experimenting on the oxidation of vegetable carbon in char, and found that it was not removed in any appreciable quantity below a low red heat. At this temperature, however, the char is greatly improved by partial oxidation, and I am very hopeful that this process will prove of great value to the refiner.

Passing from improvements in the process itself, let me close this paper by a short reference to the commercial position of the industry during the last twenty-five years. While there have been fluctuations, amounting to prosperity at times, though oftener to failure and loss, the industry, as a whole, may be said to have been on the down grade throughout this period. The decline was not caused by any want of enterprise on the part of refiners. What I have said to-night is evidence that they are not slow to adopt new processes, or improvements on old ones, which promise any chance of success. It has been almost wholly brought about by the action of foreign states who give bounties to rival refiners, which enable the latter to undersell home-made sugar in British markets. A few statistics will make this plain.

The consumption of sugar in this country, which was 860,000 tons in 1875, equal to 60 pounds per head of population, grew to 1,489,000 tons in 1900, equal to 81.2 pounds per head of population. During the same period, the sugar refined in this country fell from 760,000 to 610,000 tons. And the refined sugar imported—chiefly from Germany, Austria, and France—steadily increased from 100,000 tons in 1875 to 950,000 tons in 1900. In other words, the consumption increased 81.5 per cent. while home-refined sugar decreased 20 per cent. and foreign refined sugar increased 950 per cent! In 1875 88.5 per cent of the sugar consumed in this country was refined in Britain and 11.5 per cent abroad. While in 1900 only 39 per cent was refined in Britain and 61 per cent abroad. These figures speak for themselves, and show the enormous injury done to this country by the imposition of foreign bounties. But for them the growth of sugar-refining would almost certainly have kept pace with the growth of consumption, and many of the refineries closed during the last quarter of a century would still be working profitably.

It is worth noting in this connection the diminution of refineries during the period under review. In 1875, 18 firms were refining sugar in London, and two new refineries were started a few years later, making in all 20 for London. There were 9 in Liverpool, 3 in Bristol, 2 in Manchester, 1 each in Earlestown, Plymouth, and Newcastle-under-Lyne, 13 in Greenock, 1 in Leith, and 1 in Dublin; total, 52. In 1900 only 2 were working in London, 3 in Liverpool, 1 in Earlestown, and 5 in Greenock; total, 11. Deducting the latter total from the first we get 41 closed. To this has to be added another refinery, making 42 in all. For, some years ago, a firm of Liverpool refiners courageously tried to stop the import of foreign refined sugar on the east coast of England by establishing a refinery at Rawcliff, near Goole, which they worked on a Continental model; but after a run of two or three years at great loss, had to abandon the project.

Thus we have seen that 42 refineries have been extinguished in Great Britain and Ireland during this comparatively short period. Speculation and other causes were in a measure accountable for the closing of some of these. But the baneful influence of foreign bounties was noticeable here too. For it caused great fluctuations in the production of beet-root sugar on the Continent, with even greater fluctuations in the price of the raw material. The refiners here, who have to buy ahead to supply their wants, became the victims of these unnatural movements. Although most of them made heroic efforts to survive, we need not wonder that some refiners succumbed in the struggle for existence against such odds. The wonder rather is that there are any left. The remnant struggle on, buoyed up with the hope that in the near future our government will yet be brought to reason, and take some action which will prohibit the importation of bounty-fed sugar into this country, or by some other means equally effective, put a stop to the unfair competition of foreign refiners, and save from total extinction an old, honorable and legitimate industry, which gives employment, even yet, to large capital and a considerable number of workmen.

When in spring last it became known that a duty was likely to be put on sugar, refiners were hopeful that the Chancellor of the Exchequer would make it differential, so as to recover the greatest duty from the sugars which received the largest bounties, but when the duty was declared it was found to bear with equal incidence on sugars of all origin, leaving the position, so far as the refining industry is concerned, practically where it was.

BALATA AND ITS EMPLOYMENT.

Even at the present day to a large number of people, inclusive of many whose position in scientific and industrial circles would lead us to expect better things, the terms "india-rubber" and "gutta-percha" are synonymous. We are not concerned here in putting this confusion of ideas to rights; the matter has merely been referred to as affording good reason why a similar confusion should exist with respect to gutta-percha and balata. In this case we readily admit that the misconception as to identity is largely justified, not only by reason of close analogy in the nature and properties of the two bodies, but also from the fact of the literature concerning balata being of an excessively scanty nature, and, what is more, in many respects calculated to mislead rather than to enlighten those who, in complete ignorance of the subject, turn to it for mental illumination. Several circumstances having of late combined to attract attention to this somewhat obscure, albeit interesting, and important body, we think that the presentment of a general article dealing with the facts of its occurrence and applications will prove acceptable at the present time, and so in what follows an attempt will be made, in such detail as the exigencies of space allow of, to put the present situation before our readers. Although the balata of commerce, as derived from the *Mimusops balata* of South America, is quite a distinct product from gutta-percha as obtained from the *Dichopsic gutta* and allied trees of the Malay Archipelago, yet there are sufficient chemical and physical grounds for looking upon balata as an inferior brand of gutta-percha, and for employing it as a substitute for the latter in cases where the use of the best quality of gutta-percha is not absolutely imperative.

Exactly how far the use of balata instead of gutta-percha has proceeded is a matter which must remain in doubt, the facts being known only to the managers of factories concerned with submarine cables and to the golf-ball trader. For some applications of gutta-percha this body may be, and undoubtedly is to some extent, replaced by balata, the price of which offers a decided advantage. A point, and an important one withal, in connection with this statement is, that owing to the collection of gutta-percha being almost entirely without responsible supervision, a considerable intermixture of gutta-milks takes place; and if what is supposed to be pure gutta is not mixed before arrival in this country actually with balata, it frequently contains bodies of equally inferior quality, compared, that is, with the best gutta. It cannot be said that we are in possession of much detailed scientific work in the chemistry of balata, nor does it seem desirable in the case of a general survey like the present to encumber space with enlarging on what is known. It may, however, be said that balata in common with gutta-percha contains a large amount of certain resins, amounting to from 40 to 50 per cent. In the case of gutta, the amount of resin found is extremely variable; but taking the best gutta with the ordinary supply of balata, it is found that the amount of resins in the former average about 20 per cent less than in the latter. The best gutta can then by this test be readily distinguished; it is in the case of inferior qualities of gutta, or so-called gutta, that difficulties arise in discriminating from balata, and he would be a very confident chemist indeed who undertook to be precise upon the deductions from his analytical data. The matter is not one, perhaps, of any very great importance, the use of both these substances being confined to but a comparatively few firms, and such, moreover, as have sufficient technical knowledge at their command to ensure the safeguarding of their interests. It does, however, seem, we may remark parenthetically, rather curious that bodies worth two or three shillings a pound should be bought and sold to such an extent upon the slightest of tests. The insufficiency of such tests as are in common use is generally admitted, though the difficulties in the way of their substitution by something based on more accurate lines seem too great to enable them to be seriously considered. Balata, it may be said, is more uniform in quality and price than is gutta-percha, and its purchase is not attended with the doubts and misgivings which we know from experience are rampant in the minds of small consumers of gutta-percha.

So much for some general considerations. Turning now to the production of the body in South America, an important fact to be noticed is the shifting of the scenes of greatest activity from the Guianas to Venezuela, the output from this country having in the last two years risen to a very large extent indeed. Statistics are apt to bore the general reader, and we shall refrain from reproducing consular reports which bear striking testimony to the rise and progress of the balata industry in Venezuela. It is a fair inference to draw from this extension of the business westward from Trinidad, that the balata trees in the northern districts of South America are both abundant and widely distributed, and that no failure of the supply to meet the demand need be apprehended, for the present at any rate. Indeed, the indications all seem to show quite the reverse state of affairs, and that over-production, if not at present noticeable, will before long act as a bar to further exploitation. What becomes of all the balata at present shipped from Bolivar is a matter—almost indeed a mystery—which has exercised the minds of a good many people, because its applications are neither numerous nor extensive. We are not prying into trade secrets, but it may turn out that the prevailing idea in British Guiana, that the balata shipped goes for the submarine cable manufacture in England, is not wholly beside the mark, though we are aware that it has been expressly stated by British experts that balata cannot replace gutta for this purpose. The bulk of the balata produced goes to Europe, the United States apparently not having found any extended use for it. The States, it must be remembered, do not make their own deep-sea cables, a rather sore point with some of the senators, nor do they supply the full home demand for golf balls; facts which may or may not have a connection with the much greater demand for balata in Europe than in America. Hamburg, Rotterdam, and London are the principal ports of arrival, the large amount received at the first-named place being, no doubt, explicable by the fact of German firms being chiefly interested in the Venezuelan production.

Reference has been made to the possible use of balata in cable work and in golf balls, and mention may now be made of a purpose to which the bulk of the balata coming to Great Britain is put. The engineer needs hardly to be told that we have in mind the balata belting so widely known in connection with the firm of R. and J. Dick & Co., the late head of which, Mr. James Dick, only quite recently received obituary notices in many of our papers. This firm, who use balata in connection with boots and shoes, as well as for belting, are quite the largest buyers of the commodity in Great Britain, if not, indeed, in the world; and their presence in the market as buyers has a considerable influence upon prices. The number of transactions in balata is not large; indeed, one a week may be taken as approximately correct, and any sudden demand would cause a rise in price. It is computed that of late years about 1,000 tons per annum of balata has come to London, and that of this quantity Messrs. Dick take somewhere about one-half—figures which we give for what they are worth. The balata belting, it may be said, was the invention of the late Mr. Robert Dick, whose patent mentioned gutta-percha, balata, and canvas specifically. Probably, though it is but conjecture, balata is used more for its cheapness than for any special advantages it shows over gutta-percha, the former, although fluctuating in price, never having exceeded 2s. 6d. per pound during the last couple of decades. The present quotation, it may be said, is rather under 2s. per pound; and although, as we have indicated above, there is plenty of the material to draw supplies from, the expense of collection in somewhat inaccessible districts, coupled with the scarcity of labor, will continue to react against any considerable reduction of price.

It may be mentioned that there is an almost insuperable difficulty in getting at any correct idea of the amount of balata received at European ports, because the official statistics of Great Britain lump it with gutta-percha, while the Germans give even less means of judging, because rubber, gutta-percha, and balata all figure under the same head. As indicated, the Guianas, which were until recently the main source of the balata occurring in commerce, have now been superseded by Venezuela; and some reference to the mode of gathering in this country may prove a useful addendum to the present article, though it cannot be said to differ much from what has been in practice in British and Dutch Guiana and Trinidad for many years. The wasteful practice of felling the trees seems to be almost universal, the difficulties attending a satisfactory tapping of tall trees being enough to decide in favor of their destruction. Thoughtful people will deplore this filling of the needs of the moment at the probable expense of those of the future; but unless some evidence is brought to bear to contradict the confident assertion of the present exploiters of the forests that there is no danger whatever of the supply running short, it hardly seems likely that any serious effort will be made to alter the mode of procedure. The case is not exactly parallel with

those of rubber and gutta-percha; but, all the same, it does seem an unenlightened policy to cut down the trees, unless, as we believe has long been the case in some districts, the wood is looked upon as being of more importance than the balata. There is certainly no waste of balata when the tree is felled, because a process, the exact nature of which is kept a secret, is in use for extracting the balata from the bark by a solvent. The product is prepared in two forms—sheet and block. The former is obtained by the gradual sun-drying of the milky sap in shallow pans, which are made either of tin-plate or of wood lined with leaves. The block is prepared by boiling the sap in large kettles until it is of doughy consistency; both sorts are found in the London market, the sheet, however, being the better quality of the two. The statement that from 15 pounds to 21 pounds of balata are yielded by each full-grown tree brings to an end this brief synopsis of the procedure in the forest.—Engineering.

THE MILK QUESTION AND MORTALITY AMONG CHILDREN.

EMILE BERLINER has published an interesting comparison of the mortality of children in America and in Germany, for the purpose of showing the effect of the proper handling of milk on social conditions.

Not long ago some one remarked that the rate of mortality among children was an excellent measure for the standard of civilization which a community enjoyed. It was asserted that not only is the vitality of children a true guide to the physical and mental condition of the parents and their environments, but that the degree of care, both qualitatively and quantitatively, bestowed by governments on preventive sanitation can well be judged by the amount of sickness contracted by children, or by both.

Emile Berliner selected for his purpose two cities of approximately the same size—Hanover and Washington—both justly claiming a highly advanced civilization, both favored by good municipal government, both in the category of cities not situated within the direct reach and influence of transoceanic traffic with its attending danger from far-off infection.

One should suppose that Germany with its splendid schools, its fine literature, its thousands of professors, its army of authorities on scientific subjects, and its highly organized police supervision, would turn out to be foremost on the subject of preventive sanitation, and exhibit a percentage of child mortality below the average. This at least was the conclusion which would naturally force itself on anyone who would be asked to give, prior to investigation, an offhand opinion on this subject.

In the case of the city of Hanover in particular would that offhand conclusion be supported by the fact that this town of about 200,000 inhabitants had for years enjoyed a particularly fine drinking water, and had probably on that account escaped the ravages of a great cholera epidemic which at one time devastated the rest of Germany and the immediately surrounding countries. Furthermore, Hanover had for years been the seat of a magnificent Institute of Technology, its streets had always been kept scrupulously clean, its parks and woods reach the very heart of the town, and its gymnasiums and swimming and bathing establishments are sources of pride to the old citizens and the new.

Compared with such a favored German city, the capital of the United States showed several decidedly weak spots. Truly Washington also has its army of advanced thinkers employed by the national government, its streets are clean, its parks are scattered everywhere, and its municipal government is equally free from the boodler and the professional politician.

But on the other hand, it has nothing but unfiltered Potomac water to drink, and of its population one-third are negroes, a majority of whom are ignorant, careless regarding sanitation, superstitious in a high degree, and naturally sluggish when it is proposed to institute reform and the advantages of modern ideas.

If, therefore, the mortality among children had proven to be twice as great in Washington as in Hanover, it would not have caused surprise, when comparing the conditions in both towns as they appear on the surface. When, therefore, Berliner found that the mortality among children in Hanover was 60 per cent greater than in Washington, it at once occurred to him that the condition of the milk traffic and the milk question in general would probably furnish a clue to this surprising state of affairs.

In the year 1901, the total number of deaths in Hanover was 4,132, of which 1,871 were children under 5 years of age. Rate: 45 per cent.

In the year ending June 30, 1902, the total number of deaths in the District of Columbia was 5,947, of which 1,652 were children under 5 years of age. Rate: (under) 28 per cent.

If the white population alone be here considered, the figures are: Number of deaths among the whites, 3,259, and among the children under 5 years of age, 730. Rate: 22 per cent.

All these figures are from the officially published records of both cities.

Emile Berliner next turned his attention to the milk question as it exists in Hanover. There are two so-called sanitary dairy establishments which charge a much higher price than the average dairy for their output, and which are patronized by the better classes and by the physicians. Both establishments are supposed to be occasionally visited by physicians for investigating their condition and the health of the cows.

Outside of these two favored dairy places, the rest of the milk is brought into town from the surrounding villages under conditions which, to say the least, are deplorable.

That these conditions are not altogether unknown to the authorities at Hanover, was shown by the fact that these physicians recommended that the milk be boiled at least five minutes in order to kill all bacteria. But it has been proven, notably by Dr. Park of New York city's Board of Health, that the chemical products of bacteria are not wholly destroyed by boiling, and certain one not at all. Furthermore, prolonged boiling renders milk harder to digest for children with weak stomachs.

There occurred in Hanover in 1899:
23 deaths of scarlet fever.
82 deaths of measles.
551 deaths of intestinal troubles, including cholera infantum.

To the student of the milk question, the first two figures are closely connected with the purity, or lack of it, of the milk supply.

In the year 1899-1900 there occurred in the District of Columbia:
23 deaths of scarlet fever and
41 deaths of measles.
In the following year:
7 deaths of scarlet fever and
17 deaths of measles.
And in 1901-2:
15 deaths of scarlet fever
8 deaths of measles.

And it is noteworthy that these decreases were coincident with the instituting in Washington, both by the Health Office and by other parties, of a crusade against milk contamination.

The death rate alone is not entirely a measure for the state of health of a city. This is more perfectly judged by a number of cases of different diseases; and unfortunately the number of cases of scarlet fever, diphtheria, and typhoid which are reported and published weekly by the Health Office in Washington are not so reported in Hanover.

Measles are likewise not reported either in Washington or in Hanover. With the number of deaths from measles being sometimes two to three and one-half times greater than scarlet fever, why cases of measles are not reported in Washington is something Berliner is unable to find an explanation for. But in the District of Columbia scarlet fever and diphtheria *decreased* under the above-mentioned campaign against milk contamination.

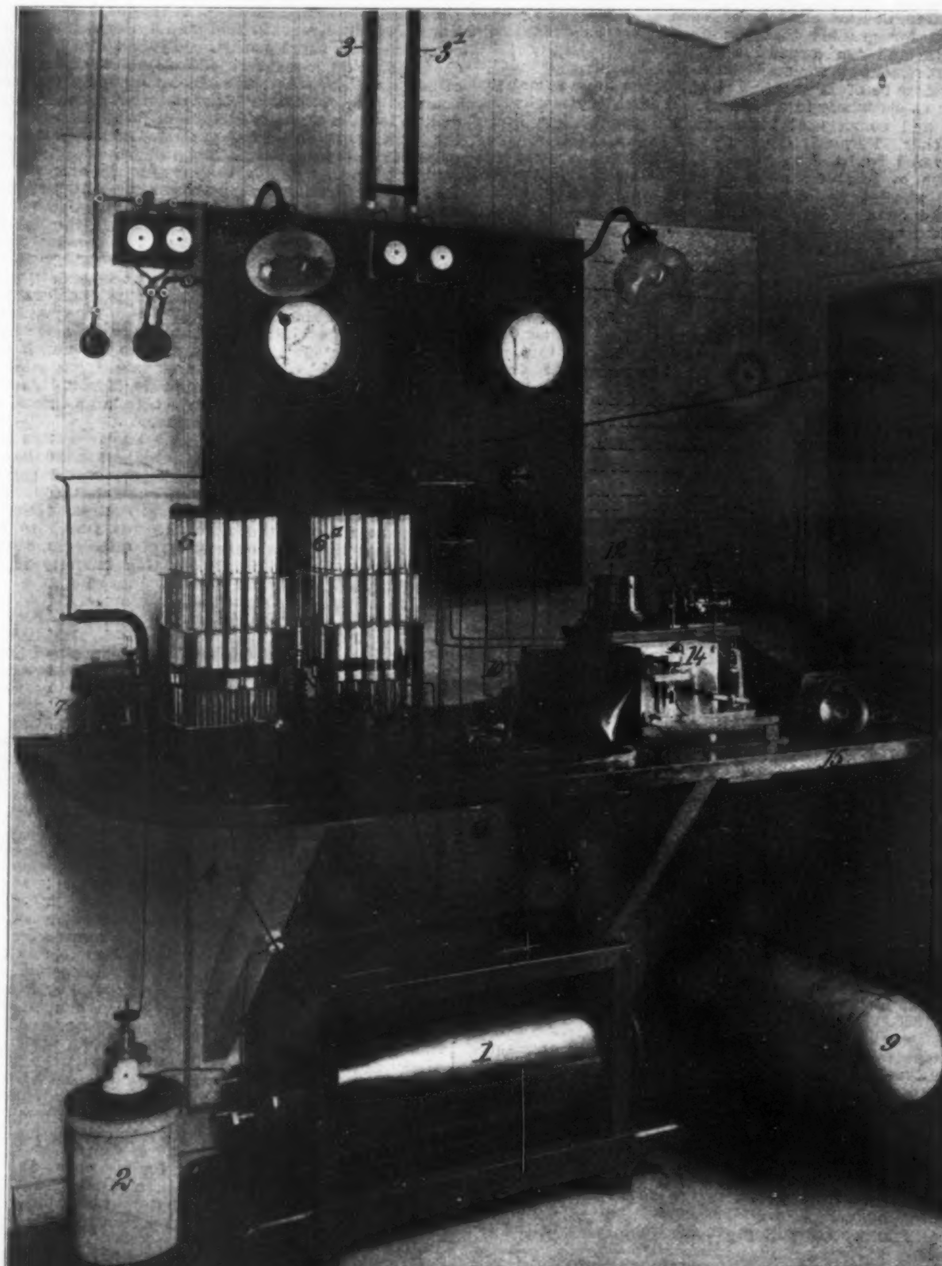
To Make Solid Loose Nails in Walls.—As soon as a nail driven in the wall becomes loose and the plastering begins to break around it, it can be made solid and firm by the following process, which we republish from the Druggists' Circular and Chemical Gazette: Saturate a bit of wadding with thick dextrin or glue, wrap as much of it around the nail as possible and re-insert the latter in the hole, pressing it home as strongly as possible. Remove the excess of glue or dextrin, wiping it cleanly off with a rag dipped in clean water, then let dry. The nail will then be firmly fastened in place. If the loose plastering be touched with the glue and replaced it will adhere and remain firm.

PORTABLE WIRELESS TELEGRAPH EQUIPMENTS IN THE GERMAN ARMY.*

By A. FREDERICK COLLINS.

IN a series of rigorous experiments of the Braun-Siemens & Halske system of wireless telegraphy, performed at the instigation of the Imperial German government, the Royal Military Airship Battalion, which was detailed to make the tests, reported favorably on the practicability of the scheme.

For this purpose the Braun-Siemens & Halske Company, of Berlin, constructed some especial equipments, consisting of transmitters and receivers for wireless telegraphy to withstand the exceptionally heavy service which would necessarily be exacted by the strenuous conditions and the harsh treatment which are characteristic of army service. The instruments, which were mounted on the regulation gun carriages, were made as compact as possible, the entire arrangement being shown in the accompanying photographs.



INTERIOR OF A BRAUN WIRELESS TELEGRAPH STATION.

These accouterments for military signaling without wires consisted of apparatus installed at two permanent stations—at Gross Möllen and at Saprintz—both of which employed masts for suspending the vertical wires, and three portable equipments, the maneuvering taking place in a zone or field of force approximating thirty-five miles.

The coherer employed as a wave detector in wireless telegraphy is an instrument of exceeding sensitiveness, and usually it has been regarded as an extremely delicate contrivance also; but in the light of these tests, while it was found to be almost ideally sensitive, it was far from being delicate, as the following illustration will show.

The wagon carrying the transmitting and receiving apparatus was drawn at high speed across country, and in five minutes after the order was given the commander of the battalion to "make ready," the

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

entire equipment was in working order, including the aerial wire or antenna, which had been in this short interval elevated to a height of three hundred feet by means of a kite. Under these trying conditions the receiver—of which the coherer is the most delicate part—operated perfectly.

The Braun-Siemens & Halske coherer is, however, constructed on radically different lines from its predecessor, in that it is not a vacuum coherer, i. e., the tube is not exhausted of its air; again, glass does not enter in its make-up, polished hard rubber tubing taking its place, making it practically unbreakable.

When the wind is light the vertical wire is raised by means of a tailless kite, such as the Malay or, as its improved form is termed, an Eddy kite; when the weather is heavy and the wind stiff, a cellular kite, such as the Blue Hill box kite, is utilized; and should there be no wind blowing at all, a small hydrogen balloon is used. A cylinder of compressed hydrogen gas for filling the balloon is part of the outfit, and it is thus evident that provision has been made for meeting any emergency which may arise.

The induction coil of the transmitter is operated by a direct-current dynamo connected with a gasoline engine, all of which is placed in the rear carriage, while the auxiliary apparatus, including the receiver and reserve parts, are arranged in the front carriage; the carriages are constructed on lines identical with the regulation gun carriage.

BRAUN PORTABLE WIRELESS TELEGRAPH OUTFIT FOR MILITARY USE.

One of the notable features of the Braun-Siemens & Halske apparatus is the absence of earthed terminals, which have been found so essential in all other systems; instead of the earth, cylinders of zinc or copper are employed, having the requisite electrical capacity, which is a decided advantage.

In the portable sets no material effort has been made toward the timing of the various instruments operating in the same zone; but for purposes of symmetry of the electrical proportions, adjustable capacities and inductances are included.

The portable apparatus is similar to that of a permanent station equipment except that it is constructed much more compactly; the principal features of the system are well brought out in the accompanying interior view of one of their test stations.

The induction coil 1 is shown resting on the floor; its primary is connected to a source of electromotive force through the electrolytic interrupter 2 by means of the feeders 3, 3'; the terminals of the secondary 4, 4' are connected with spark-balls forming the air gap in a glass cylinder 5, which is filled with a viscous compound such as vaseline. To either side of the spark-gap 5 are a series of miniature Leyden jars 6, 6', and by removing from or adding to their number a capacity of the desired value is obtained for the oscillator or radiator system, which will correspond in frequency to the natural period of the resonator or receiving circuit.

THE PORTABLE MILITARY WIRELESS TELEGRAPHIC APPARATUS IN USE.

The frequency of the oscillations may be stepped up or down to any given rate per second by means of the high potential transformer shown at 7. The primary of this oil transformer is connected to one of the spark-balls, and the opposite terminal to the opposite spark-ball. The secondary terminals of the transformer lead to the antenna or vertical wire through the switchboard, and thence through the window, and to the zinc cylinder, representing a capacity equal to that of the suspended wire and approximately a capacity equal to that of the earth. The receiving apparatus is shown to the right; the switch on the board serves to throw the receiving apparatus into connection with the antenna and capacity.

The antenna and cylindrical capacity are connected with the primary of a small transformer 10, the secondary of which is connected to the coherer 10*a* through a condenser not shown in the picture. The coherer is in series with a sensitive polarized relay 12, and is actuated by a single dry cell; the auxiliary circuit of the relay actuates a mechanical topper 13 and the Morse register 14; or all this heavy apparatus may be supplanted by a coherer and a pair of head telephones shown in 15.

In the summer of 1902 two experimental stations were erected on the East Sea (Ostsee); these were located at Sassmitz on the Rügen and Gross Möllen on the Pomeranian coast. These stations have masts 75 feet in height; the antennæ consist of a single wire leading from the apparatus upward to the yardarm, the upper third portion being inclosed in a net of six parallel wires.

The Austrian and Danish navies have been recently supplied with the Braun-Siemens & Halske system of wireless telegraphy, and the United States navy is at the present time testing its merits. The field for signaling through space is ever broadening, and it will not be long until every vessel in the merchant service will be equipped with some system; at the present time, while the public eye is fastened on the commercial value of wireless telegraphy, the great work of installing systems in the armies and navies of the world powers is overlooked in virtue of the secrecy with which it is done; the effort, nevertheless, is being directed systematically in these branches of organized warfare, and when completed, one more link in the great chain of peace will have been forged.

CONTEMPORARY ELECTRICAL SCIENCE.*

Physiological Effects of Röntgen Rays.—The skin disease called radio-dermatitis is the consequence of excessive exposure of the skin to Röntgen or Becquerel rays. Its pathology and treatment are fully described by Dr. Oudin. It is a painful and troublesome malady which may last for eighteen months, and it is difficult to cure, though it does not appear to give rise to infectious or dangerous complications. The minor and general effects include vomiting (which often sets in the next day in consequence of abdominal radiography), palpitation of the heart, trembling of the fingers, and local loss of sensibility. The first symptom of acute and deep-seated radio-dermatitis is a reddening of the skin, which appears 24 to 36 hours after exposure. From 10 to 25 days after this the skin becomes covered with small vesicles, and itches violently. At the end of this period the skin begins to peel off, and is painful to touch. This phase lasts 10 to 15 days, at the end of which time healing often sets in. In more serious cases, however, ulceration sets in, which may last for many months. It is accompanied by epilation and a darkening of the skin over wide areas. As regards treatment, nothing has yet been found capable of stopping the development of the disease, though applications of cocaine or orthoform dressings give some relief. The electric effluvium and red light appear to accelerate the course of healing, and it is supposed that red light would, to a certain extent, counteract the effects of Röntgen rays, as they somewhat resemble the effects of ultra-violet light. Besides this acute radio-dermatitis, which is practically confined to over-exposed patients, there is a "chronic radio-dermatitis" which attacks the operators. It effects more especially the fingers. The skin becomes red and swollen, and it is often impossible to close the hand. The nails usually become thin, brittle and creased—sometimes they fall off entirely. There is no treatment for this malady except the suppression of the cause. The author uses fencing gloves containing a padding of very fine brass wire to protect his hands. To protect his patients he uses fairly strong rays and short exposures, gradually increasing in duration. He never lets the anti-cathode become brighter than cherry-red, but brings the tube within 5 cm. of the skin. For difficult radiographs he gives an exposure of 30 seconds at the first sitting, one minute two days afterward, and so on until the exposure is increased to three minutes. Then the sitting is interrupted for eight days, and if, after that, no redness shows itself, the exposure can be gradually raised to five minutes, which must not, however, be surpassed. As regards the precise action of the rays in producing the disease, we are as yet in the dark.—Oudin, Archives d'Electricité Médicale, September, 1902.

Radio-activity of Cave Air.—Elster and Geitel have shown that any conductor becomes radio-active when charged and exposed to air, especially when the air is contained in a closed subterranean space. To shed some light on the origin of this radio-activity, the same authors have made experiments on air inclosed for three weeks in a boiler and on air sucked up out of the ground. If the activity is due to a process within the air itself, it will be evolved in the boiler, and if it is due to contact with the earth, it will be shown in the air sucked up. The authors pushed an iron tube into loose garden soil, and inserted a glass tube into it, through which the air was sucked into an electroscope. The results were altogether in favor of the view that the activity of the air in a cave or cellar is due to contact with the earth and to exhalation of ground air. For the electroscope was discharged in a few minutes by the air sucked up, whereas the air in the boiler did not show any extraordinary radio-activity. The authors, therefore, claim to have traced two distinct sources of radio-activity, one of them being the action of the sun upon the higher strata of the atmosphere, and the other being the exhalation from the soil of air which has been in intimate contact with it, and which diffuses up through capillary passages in the ground.—Elster and Geitel, Physikal. Zeitschr., September 15, 1902.

Becquerel Ray Photographs.—J. Elster shows how to obtain Becquerel radiographs with the simplest means. The radio-active substance is obtained by exposing negatively charged copper wires to the air, and rubbing off the surface layer after exposure. If cotton wool is used for rubbing it off, it should be moistened with a little hydrochloric acid. This is afterward neutralized with ammonia and eliminated by igniting the cotton wool. The activity of the ashes is the same as that of the cotton wool. The radio-activity lasts for about five hours. As its loss is greatest at first, the exposures must be made as soon as possible. To save time it is advisable to substitute a piece of leather, moistened with ammonia, for the cotton wool, since it can be quickly dried in a spirit flame. The exposure is then made for about four hours, and the leather is renewed. After about five such renewals good radiographs of lead stencils are obtained through aluminium foil 0.1 mm. thick. The radio-activity of the exposed wires depends, of course, to a great extent upon the weather. Air free from mist and dust is specially favorable. But the best of all is a cellar free from dust, and the author has found that the leather rubber over charged wires suspended in a cellar exerted some visible action upon a fluorescent screen. He points out that the whole surface of the earth is practically a cathode.—J. Elster, Jahrbuch für Photographie, 1902.

Polonium.—If pitchblende is powdered and ignited in a porcelain crucible, and the lid is kept cool, the latter is covered with a reddish-gray deposit which shows a strong radio-activity. This substance, referred to as "volatile" by Giesel, cannot have a merely "induced" radio-activity, since its activity is about six times that of the pitchblende, whereas radium never induces an activity equal to its own in a body it influences. O. Behrendsen proves that the deposit consists largely of polonium. On covering the deposit in question and a radium preparation with imitation gold film of the same thickness, he found that the former lost 85 per cent and the latter only 20 per cent of its original radio-activity. This great absorption of the rays from the deposit is only found in polonium rays. Another point of resemblance is the volatility of the substance and the comparatively short duration of its radio-activity. Like polonium, the volatile deposit has a preference for bismuth. If pieces of various metals are covered with it and ignited, bismuth shows as a result an activity ten times greater than any other metal. This preference for bismuth has been utilized by Marckwald for the electrolytic preparation of polonium. The author considers it definitely established that polonium is an independent element.—O. Behrendsen, Physikal. Zeitschr., September 15, 1902.

Electricity in the Alizarine Industry.—Alizarine was formerly obtained from the root of *Rubia tinctorum*, but since Graebe and Liebermann discovered that alizarine is a derivative of anthracene, it has been manufactured from coal tar by treating anthracene with sodium bicarbonate and sulphuric acid. This gives anthraquinone, and according to the modern process, this is treated with fuming sulphuric acid, and the monosulphite is fused with caustic soda. To obtain anthraquinone from anthracene, sodium bicarbonate is necessary. Up to the present, the methods for recovering the chromium salt contained in the mother liquor as chromium sulphate have been very troublesome. The electrolytic recovery of the chromium has hitherto been hindered by the fact that between the two electrodes a diaphragm is necessary, and that no diaphragm was found capable of holding the strongly acid solution for any length of time. This difficulty has been overcome by Leblanc's invention of dia-

* Compiled by E. E. Fournier d'Albe in the Electrician.

phragms consisting of 25 per cent alumina and 75 per cent silica, which not only are very durable, but also have a low resistance. One German aniline dye factory has been transferred to the neighborhood of Augsburg, where there is sufficient water power to yield a cheap supply of electrical energy for the new process. —H. T. Simon, Jahresber. Phys. Verein Frankfurt, 1902.

RADIUM, POLONIUM, AND ACTINIUM.*

By WILLIAM J. HAMMER.

SINCE the discovery a few years ago by M. Henri Becquerel of the remarkable uranium radiations which have since been known by his name, such an amount of attention has been given by physicists to the study of radiant matter, and to speculative theories as to the constitution of matter, that it will probably be some time before our views can settle down and adjust themselves to the new phenomena which have been presented and are daily being brought to our notice.

Becquerel demonstrated that compounds of uranium, and especially the metal itself, prepared in the electric furnace, possessed very great radio-activity. Thorium compounds, especially thorium oxide, are next in activity, though far weaker.

Mme. Sklodowska Curie and M. Pierre Curie noted that other elements were inferior to these, and that the compounds were inferior to the metals themselves. Bohemian pitchblende and two other compounds of uranium suggested to them by their greater radio-activity to that of pure uranium, that some new substance existed more active than uranium, and after most exhausting and painstaking investigations, they discovered a metal identical with bismuth in its chemical characteristics, and far more radio-active, which they named "polonium" after Poland, Mme. Curie's fatherland. A further search resulted in the discovery of another new metal very similar to barium in its chemical properties, which they called "radium," which was even far more radio-active. This was followed by the discovery by M. A. Debierne of a third element, which he has named "actinium," which has chemical characteristics similar to thorium. It has as yet not been fully demonstrated that these three are actually new elements, as none has as yet been secured in a pure state. (See note 1 of Appendix.)

It is not my purpose to-night to go fully into the investigations which have been made in these remarkable substances, with which many of you are doubtless familiar; but in view of the interest which radium has excited in the scientific world, and as there are probably few in this audience to-night who have had an opportunity of seeing this remarkable, and up to the present time exceedingly rare, substance, I take pleasure in presenting a small quantity for your consideration, which I have secured through the courtesy of Prof. Dayton C. Miller, who imported the same from Paris. The tiny sealed glass tube which I hold in my hand contains about 1 gramme of radium, which cost in Paris about ten dollars.

I have prepared a few notes regarding certain properties of radium, which I will read, and which I trust will prove of interest,† after which, if the lights are put out, I will pass around the room, and you can observe not only the illumination produced by the radium itself, but also the radio-activity of the cotton which I will wrap around the tube.

An extensive dealer in chemicals informed me recently that the treatment of 5,000 tons of uranium residues would probably not result in the production of a kilo of radium. The present market price in this country is $4.50 per gramme, or approximately $2,000 a pound.

M. and Mme. Curie and H. Giesel have succeeded in further purifying radium, and I understand that a preparation will shortly be on the market here at the cost of $35 per gramme. The chloride and bromide of radium are the most brightly luminous compounds, but all the salts are more or less radio-active.

The radium preparation which I am able to show you to-night differs from such substances as sulphate of lime and various compounds of barium, calcium, strontium, uranium, etc., which possess the property of glowing in the dark when exposed for some time to light, or are rendered active by electrical or heat vibrations, in that radium requires no such exposure to become incandescent, but will glow for months and even years, and also has the property of causing other substances near it to become radio-active, and to retain this activity in many cases for a long period. Radium has been called a constant source of "X" or Röntgen rays and cathode rays.

H. Becquerel estimates that the energy expended by radium is a few C. G. S. units per second, and a few ten-millionths of a volt, and that at this rate the loss of matter would be about 1 milligrm. in a thousand years. He also finds that the radio-activity of radium is 900 times that of metallic uranium, while that of polonium is only 400 times. (See note 2 of Appendix.)

He also calls attention to the facts demonstrated by M. and Mme. Curie and himself, that radium radiations carry negative charges like cathode rays, and like cathode rays also can discharge electrified bodies at a distance as well as render the air gap between the plates of a condenser conducting, and the current passing susceptible of measurement by an electrometer. Also that many bodies when exposed to radium influences acquire temporarily the power of rendering the air conducting and of discharging electrified bodies, all of which afford proofs of the contention that there is in reality a continuous emission of energy by transport of matter from radio-active bodies; and H. Becquerel estimates the speed with which these particles are radiated at half to two-thirds the speed of light.

These investigations have also shown that radium radiations are of three kinds, a portion deviable by a magnetic field, a portion non-deviable and readily absorbed, and a third weaker portion of diffused, non-deviable rays attributable partly to secondary rays.

M. and Mme. Curie state that the deviable rays have the greater penetrative effect, but constitute but a small portion, and that the non-deviable rays, which constitute the major portion, do not travel further in the air than 7 centimeters from the source. According to M. Becquerel there seems to be no difference in the deviable qualities of radium rays in the air or in a vacuum. M. and Mme. Curie show that polonium only emits non-deviable rays, and that these only travel 4 centimeters from the source in air.

Giesel's polonium, on the contrary, emits both deviable and non-deviable rays; and J. Elster states that magnetic deviation of polonium rays is produced in a vacuum, and seems to exceed deviation of radium rays under same conditions.

S. Meyer and E. R. Von Schweidler, in studying the absorption of radium rays, call attention by plotted curves to the fact that the first few hundredths of a millimeter are most effective in the absorption, and that it may be concluded that with radium rays, as in the case of Röntgen, uranium, and thorium rays, the radiations consist of a large number of rays of different nature.

According to M. and Mme. Curie, radium rays act in many ways like light. They reduce silver salts, peroxide of iron, and bichromate of potash in presence of organic substances; but they also color glass, porcelain, and white paper, and they transform greenish-yellow platino-cyanide of barium into a brown variety.

Giesel had prepared platino-cyanide of barium with a trace of radium. This spontaneously became brown, and it then polarized light like tourmaline. He also found that this colored rock-salt just as cathode rays do, or the vapors of alkaline metals, and furthermore showed that radium salts, brought near the temples, or to the closed eyes, produced a sensation of light.

M. Becquerel, referring to the chemical action of radium rays, says that radium and uranium rays act upon silver gelatino-bromide, but produce no effect upon Daguerre plates, or upon photographic papers, and says that colorations of glass, porcelain, paper, and certain crystals, as well as the painful physiological effects, also belong to this class of phenomena. He also calls attention to the transformation of white into red phosphorus in twenty-four hours, the reduction of mercuric chloride in the presence of oxalic acid with the precipitation of calomel, and finally the destruction of the germinating power of seeds after long exposure.

Becquerel also shows that radium rays possess the same power as the electric spark, or the prolonged action of violet or ultra-violet rays, of restoring the phosphorescent properties under exposure to heat of a body deprived of them by over-heating.

O. Behrendsen found that by cooling radium in liquid air its radio-activity was reduced more than one-half. On heating again to a normal temperature, a slight increase of radio-activity was discovered, thus agreeing with the behavior of phosphorescent bodies described by Lumière. (See note 3 of Appendix.)

Curie and Debierne state that while all bodies become radio-active when placed in a closed vessel with solid salt of radio-active barium, this effect may be increased 40 times and made more regular by using the aqueous solution instead of the solid salt.

M. A. de Hemptemne, who discovered that gas which becomes luminous at a certain pressure under the influence of electrical vibrations becomes luminous at a higher pressure when exposed at the same time to "X" rays, also found that air which became luminous only at an exhaustion as low as 33 millimeters, became luminous at a pressure of 44 millimeters, brought into proximity with a radio-active substance, and at the same time the color of the light changed from reddish violet to yellowish green.

Dr. C. Runge, the great German specialist, found that radium gave three distinct lines belonging to no other element. Demarçay had previously given these lines, together with some twelve others which he claimed to belong to radium, but thus far had not been proved to belong to radium. (See note 4 of Appendix.)

Radium rays, like Röntgen or "X" rays, produce serious physiological effects. This was first demonstrated by Messrs. Walkoff and Giesel, the latter having kept on his hands for two hours a celluloid capsule containing radiferous barium bromide. The rays acting through the celluloid caused a light redness of the skin, and two or three weeks later inflammation set in, and the skin finally sloughed off.

M. Curie repeated Giesel's experiment upon himself, using radiferous barium chloride, acting through a thin sheath of gutta percha, upon his hand. The activity of the substance was comparatively feeble, being about 5,000 times that of metallic uranium. The rays left a red spot on the hand 6 centimeters square, which appeared like a burn, but gave no pain. In a few days the redness increased, but on the twentieth day crusts formed, ending with a sore which needed dressing. On the forty-second day the epidermis commenced to form on the edge, and fifty-two days after the action 1 square centimeter remained sore and of a grayish color.

M. Becquerel, on carrying a small sealed tube containing a few decigrammes of very active radiferous barium chloride, the activity of which is 800,000 times that of uranium, underwent an experience of the same kind. The matter inclosed in the glass tube occupied a cylindrical volume of from 10 to 15 millimeters by 3 millimeters in diameter; the tube, wrapped in paper, was kept in a small pasteboard box. On April 3 and 4 this box was placed several times in a corner of a vest pocket for a period, the total duration of which amounted to six hours. On April 13 it was perceived that the radiation through the tube, the box, and the clothes had produced a red spot on the skin, which became deeper as the time passed, marking in red the oblong form of the tube, and assuming an oval form 6 centimeters long by 4 centimeters wide. On April 24 the skin fell off; then the part most affected sank in, beginning to suppurate; oleo-calcareous dressings were applied to the sore for a month, the diseased tissues were removed, and on May 22, that is to say, forty-nine days after the action of the rays, the ulcer closed, leaving a scar which marked the place of the tube.

"While care was being given to this burn," he says, "there appeared about May 15 a second oblong red spot opposite the other corner of the vest pocket in which the active matter had been placed. The exposure had been of short duration, an hour at most. Erythema now appeared, thirty-four days at least after the exciting action; inflammation developed, presenting the appearance of a superficial burn; on May 26 the skin began to fall off; on receiving the same care as the first, this burn appeared to be more rapidly cured.

"In the interval of these observations, on April 10, 11, and 12, the same tube of active matter, inclosed in a lead tube, whose walls were about 5 millimeters thick, was kept for forty hours in another vest pocket, but has so far been attended with no physiological effect.

"It may be added that Mme. Curie, by carrying in a small sealed tube a few centigrammes of the same very active matter which had caused the effects described above, had similar burns, although the small tube was inclosed in a thin metallic box. In particular, an exposure of less than half an hour produced at the end of fifteen days a red spot, resulting in a blister similar to a superficial scald. Fifteen days were required for the cure. These facts prove that the duration of the effects varies with the intensity of the active rays, and with the duration of the exciting action.

"Our hands have been also affected. There has been a general tendency to desquamation, the extremities of the fingers which have held the tubes or capsules containing active products become hard and very painful. In the case of one of us, the inflammation of the extremities of the fingers lasted about fifteen days, and indeed, after the falling off of the skin, the painful sensations have not yet completely passed away at the end of two months."

As illustrating the action of radium rays upon bacteria, E. Aschkinass and W. Caspari speak of exposing cultures of *Micrococcus prodigiosus* to a radium preparation, and state that the rays killed the germs very effectively in about three hours.

APPENDIX.

Since presenting the above paper on radium, I have visited Paris and had the pleasure of spending some time at Prof. Curie's laboratory at the Ecole de Physique et de Chimie Industrielles, and Prof. Curie has shown me some very interesting experiments and apparatus. I asked him to criticise the matter which I had prepared, and he very kindly gave me in writing the following notes which are numbered 1, 2, 3, and 4, and refer to the paragraphs in my notes which are similarly numbered.

Notes by Prof. Curie.

1. It is well known to-day that radium is a new element characterized by a special spectrum. Radium has an atomic weight equal to 225. (Refer to the report given in the Comptes Rendus of July, 1902.)

2. Radium, actinium, and polonium possess an activity which is a million times that of uranium.

3. I found, on the contrary, that radium emits exactly the same quantity of Becquerel rays when it is in the liquid air, as it does at the normal temperature of the atmosphere. The luminosity of the chloride of radium is stronger in the liquid air than in the atmosphere at a normal temperature.

4. The spectrum of radium has been fully studied by Demarçay and the rays that he points out certainly belong to him.

I asked Prof. Curie whether there existed at the present time, or whether there has ever been made, a kilo. of radium, and was informed that during the past three years only between 500 and 600 grammes of radium had been manufactured, and that this included all grades of purity, and he also stated that radium, as a metal, did not exist, practically all which had been produced thus far being chloride of radium associated with barium; but he showed me a tiny tube of chemically pure chloride of radium, which he said was the only sample of it in a pure state that existed in the whole world. It was about the size of a buckshot and contained less than three one-hundredths of a gramme, and on my inquiring its value I was told that it had any value that one wished to give it; but that $20,000 could not buy it. It was with this sample of pure chloride of radium that M. Demarçay made his tests with the spectroscope, demonstrating that radium was a new element, for it showed no lines other than those characteristic of radium.

With this sample the atomic weight of radium was also determined to be 225, being considerably higher than that of barium, which is 157.

I saw at the laboratory of the Societé Centrale de Produits Chimiques, where the radium is manufactured, a similar tube of radium of a lower grade, there being still a considerable trace of barium in it, which tube had a value of $5,000. Prof. Curie told me that he would not care to trust himself in a room with a kilo. of pure radium, as it would doubtless destroy his eyesight and burn all of the skin off his body, and probably kill him. He showed me the scars on his arm, one of which looked as if he had had a very serious ulcer, due to a radium burn, which, I understand, had taken fifty-two days to heal, and the other showed that the skin had been blistered and slightly scarred; the latter was caused by an exposure of but five minutes to some radium of very high activity; the more serious scar was due to an exposure of one hour and a half to some radium of much lower radio-activity, approximately 5,000. All of the radium manufactured in France is made under the supervision of Prof. Curie, and is tested and the samples classified by him. He informed me that whereas the best German product shows an activity of only 300 times the activity of uranium, the best commercial product which is at present on the market in France has 7,000 times the activity of uranium, and this at present costs $100 a gramme in Paris. Through the courtesy of Prof. Curie I was enabled to secure from the manufacturing

* A paper read at the 150th meeting of the American Institute of Electrical Engineers, New York and Chicago, January 8, 1903.

† Prepared from data given to the writer by Prof. Curie, also data from compilations of E. E. Fournier d'Albe, in London Electrician, Science Abstracts and other sources, these being abstracts of Proceedings of Roy. Soc., Phil. Soc., Phys. Zeitschrift, Ann. der Physik, Deutsche Phys. Ges. Verk., Chemical News, Comptes Rendus Soc. Francaise, Phys. Bull., Journ. de Physique, etc.; see also, Prince Kropotkin on "Unsuspected Radiations," in the Nineteenth Century, December, 1900.

laboratory a number of tubes of radium of varying degrees of radio-activity, and sample tubes of polonium of both bismuth-polonium metal and nitrate of bismuth and polonium, each possessing a radio-activity 300 times that of uranium, and tubes of pitchblende, uranium, uranium residues from which the radium is extracted, etc. I have also secured through the courtesy of M. Boulay, of the Societé Centrale, an interesting set of photographs made by radium rays.

DEVELOPMENT OF THE CERAMIC ART IN CHINA.

By RANDOLPH I. GEARE.

OLD Chinese legends contain statements to the effect that porcelain had been made in that country before the reign of Huang-ti, who came to the throne 2,697 years before the Christian era. Later legends refer to an official "director of pottery" and to the difference between molding and fashioning with the potter's wheel, which latter originally came from Korea. Sacrificial wine-jars, altar-dishes, coffins, cooking utensils, etc., were among the articles produced.

It has long been determined, however, that only earthenware could have been then made, nor can it be claimed that the manufacture of real porcelain (*tz'u*) antedated the Han dynasty (B. C. 202 to A. D. 220). It is true that some porcelain bottles, decorated with flowers and Chinese inscriptions, are said to have been found in undisturbed Egyptian tombs at least 1,800 years B. C., but proof that seems conclusive has been furnished, showing that the inscriptions were written in a style not introduced until B. C. 48, and later these same inscriptions were identified as quotations from poems written during the T'ang dynasty (618 to 906 A. D.).

The opinions of two eminent authorities on this point are of interest and importance. M. Julien has expressed his belief that true porcelain was first manufactured in China between the years 185 B. C. and 87 A. D., while M. du Sartel, who published an exhaustive work on Chinese ceramics, places the date some centuries later, i. e., during the T'ang dynasty.

But however this matter of date may be, whether during the Han or T'ang dynasty—and the point is certainly not without interest—it is asserted beyond question that no specimens manufactured previous to the Sung dynasty (960 to 1259 A. D.) have survived to the present day, and the vexed question is therefore largely one of historical importance. Furthermore, the productions of the finer kinds even in the Sung dynasty have entirely disappeared. Those which have survived are said to be only "céladons" of considerable solidity, or small pieces of no great fineness. "The word céladon," writes Mr. Hippisley, "was originally the name of the hero in the novel 'L'Astrée,' written during the sixteenth century. This hero was attired in clothes of a kind of sea-green hue with gray or bluish tint, and his name was subsequently applied to the clothes he wore." The Chinese equivalent of the word is "*ch'ing*," which is applied to the colors of porcelains of a blue, or a pale dull green."

Before discussing the principal characteristics of the porcelains made under the various dynasties, brief consideration will be given to the composition of Chinese porcelain, the method of shaping the paste, applying the glaze, and baking and decorating the objects, and it is but proper to add that the statements are largely derived from the catalogue of Mr. Alfred E. Hippisley, a recognized authority on the subject, who has for many years been connected with the Imperial Maritime Customs Service of China, and whose collection of Chinese porcelains is now on exhibition in the National Museum at Washington.

Porcelain consists of two essential parts: one infusible, the other fusible. The former is the paste (*pâte*), which forms the body of the object; the latter is the glaze, which gives transparency, and prevents porousness or the possibility of the object contracting under the influence of heat. The paste, which may be hard or soft, is made up of clays. These are classified according to their degree of plasticity and fusibility. The best of them is kaolin; which is a white aluminium silicate produced by the decomposition of granitic or feldspathic rocks, and is almost infusible. The soft paste contains limestone products or alkalies, which lower its degree of fusibility, so that it becomes fusible, or at least soft, at a temperature of 800 deg. Centigrade.

The crude kaolin, when freed from all impurities and ready for use in making the paste, gives a very white clay, soft and plastic. The kaolin which furnishes the glaze for the hard Sèvres, is found in abundance at Saint Yrieix, in France. The paste is roughly shaped, turned and molded when in a malleable state. It is not cast, as in Europe, and therefore the skill of the Chinese in shaping with the hands large jars and cups as thin as egg-shell is all the more astonishing. They also seem not to have learned the advantage of baking the article slightly before applying the glaze. The fact that porcelain is dilutable by water (although ceasing to be so after exposure to a temperature sufficient to turn it red) furnishes an easy method of covering it with glaze. Being slightly baked, it may be covered with a uniform layer of glaze by simply immersing it in water bearing in suspension the finely crushed material, provided that the proportions of water and glaze (with relation to the thickness of the vessel to be covered) have been fully determined. The glazes used in China are for the most part compounded from substances whose proportions vary according to their nature. Pure petrosilex (a cryptocrystalline mixture of quartz and feldspar) is seldom used, but lime added to it renders it more easily fusible, and in some cases represents as much as one-fourth of the total weight. Fern leaves also sometimes enter into the composition of the glaze, although what purpose they serve has not been fully ascertained.

Being ignorant, as already intimated, of the plan of subjecting the porcelain to a preliminary baking (under which the vessel, on account of its thus becoming less porous, may be immersed into the liquid glaze) the Chinese apply the glaze by "aspersion and immersion," or else by "insufflation." In the first of these processes the vessel is held by the outside slanting over a basin containing the liquid glaze. Enough of the glaze is then thrown on the inside to cover the surface. The outside is then immersed in the liquid. In employing insufflation, a piece of gauze is first attached to a hollow tube, and having been plunged into the glaze, the operator scatters the liquid over the vessel by blowing through the opposite end of the tube. The next operation is baking in the kiln, the bottom of which is covered with a thick layer of gravel. On this the "seggars," which are vessels of some refractory material that hold the pieces of porcelain, are piled. The object of the "seggars" is to prevent the pieces from coming into direct contact with the flames or gases. The pieces are still soft and must be placed in the seggars with great care, a contrivance of cords and sticks being used for the purpose. Then the piles of seggars are bound tightly together and the doors of the oven are shut. A low fire is kept up during the first twenty-four hours, after which the heat is increased. When the porcelain is sufficiently baked—and this is ascertained by applying a pair of pincers through holes in the top of the kiln, which are covered up during the baking—firing is stopped and all openings are closed for three to five days. This completes the operation.

In China the coloring processes used in decorating porcelain are two-fold: *colors du grand feu* and *colors de moufle*. In the former, the blue decoration under the glaze is made with a brush on the unbaked porcelain, the coloring matter being peroxide of cobaltiferous manganese. Other colors, such as céladon and red grounds, also seem to be used, although some authorities consider their production, in China at least, as due to accident rather than design. The *fond laque* or *feuille mort* is obtained by the use of oxide of iron. Black grounds are produced in a variety of ways, either by the thickness of the colored glaze, or by laying several shades of different colors one on another; or, again, by laying a blue glaze on a brown *laque*, or *vice versa*. One writer states that violet, turquoise blue, yellow, and green grounds are applied on the porcelain after it has been fired at a high temperature. All of these colors contain a rather large proportion of oxide of lead. The green and turquoise blue owe their colors to the presence of copper; the yellow to lead and antimony; and the violet, to an oxide of manganese containing only a little cobalt.

In Europe colors *de moufle* are obtained by mixing one oxide or several metallic oxides together in a vitreous flux, the composition of which varies with the nature of the color to be developed. In China, on the contrary, the oxides are dissolved, which has the effect of closely connecting the colors with enamels. Transparent enamels are vitreous compounds, the composition of which varies, according to the amount of fusibility required. Blues are supplied by oxide of cobalt; greens, by protoxide of copper; and reds, by gold. Opaque enamels, yellow or white, owe their color and opacity either to antimony, or to arsenic or stannic acid. In European porcelains these were found to scale off; but this is not the case when placed on Chinese porcelains. This is explained by the fact that the paste of Chinese porcelain being more fusible than the European, the glaze must also be more easily fusible, and the lime which is introduced into it to increase the fusibility, adapts it in some manner for closer union with the compounds forming the enamel.

None of the Chinese colors contain much coloring matter, and they are of but little value unless applied in a depth which gives the painting a relief that cannot be obtained in any other way. The harmony of the decorations thus obtained, results from the nature and composition of the enamels.

Commencing with the Sung dynasty (960 to 1259 A. D.), earlier than which there are probably no pieces of Chinese porcelain extant, the ware manufactured appears to have excelled all that preceded it, excepting perhaps one kind; and it is worthy of note that prior to this dynasty the external color of all porcelain was apparently determined by that of the glaze. In most cases only one color was used, while in a few instances vases were covered with parti-colored glaze and the different shades were liable to flow into one another in the kiln, thus forming by accident a class of objects whose decoration changed during the process of baking. The shapes and ornamentation appear to have been copied from ancient bronzes, or else the vessel took the form of some natural object. The principal porcelains made during this dynasty are the Ju-yao or Juchou, Kuan-yao, Ting-yao, Lungch'-uan, Ko-yao or Chang-yao, Chün-yao, and many others of less prominence.

The finest specimens of Juchou, usually very thin, were delicate plates and bowls, with either plain or crackled surface, and with the ornamentation under the paste. A perfect vase of this period is considered almost unique and exceedingly valuable.

The Kuan-yao was the official porcelain, and was made at the imperial factories between 1107 and 1117. Some pieces were pale white, like the moon; some pale bluish-green; and others, dark green. Later pieces were colored only bluish-green, both dark and pale in tint. This porcelain was very thin, and sometimes was crackled so finely as to resemble a crab's claws.

Ting-yao porcelain was of two kinds—Pei-ting and Nan-ting (Northern Ting and Southern Ting). The former was the more highly prized, and the pieces were brilliant white, purple, or black.

In the Lungch'-uan porcelain, the ornamentation was under the glaze, the shades of which varied from the color of grass to a deep onion green, with occasional bands of foliate or scroll pattern of a deeper tone.

When the court was removed southward in 1127, two brothers, Chang by name, gained a high reputation for their porcelain, which was made at a factory in the Lungch'-uan district; but in separate kilns. That manufactured by the elder brother was called Ko-yao, while the ware of the younger brother was known as Chang-yao. Both were céladon in color, and the chief difference between the two seems to have been that the Ko-yao was crackled, while the other kind was not.

Chün-yao porcelain was sometimes molded in grotesque form, but was usually fashioned after ancient bronzes and ornamented with scroll or floral patterns under the glaze. The best pieces seem to have had two or more colors of glaze on the same vase.

In the following dynasty, Yüan, which lasted from 1260 to 1349, the manufacture of porcelain seems to have fallen behind, excepting in the case of objects produced for the special use of the Emperor, while in the Ming dynasty (1368 to 1649), there was made considerable progress in the ceramic art, both in the fineness of the ware as well as in the excellence of the decorations. It is to the early part of this dynasty that the ornamentation of vases with arabesques and scroll-work, with landscapes, historical scenes, etc., has been commonly ascribed.

Decoration in many colors came to be more highly prized, and designs were obtained from the brushes of the best artists, which were afterward transferred to the porcelain by the most skilled workmen. The Ch'ênghua period stands most prominently forward in this dynasty, so far as the porcelain industry is concerned. Then followed the Yunglo period (1403 to 1424), during which much white porcelain, with ornamentation in blue under the glaze, was manufactured. The blue employed in these periods is said to have been brought from some Mohammedan country as tribute, and hence was known as "Mohammedan blue." Eggshell porcelain of very delicate workmanship was now produced. The Chinese call it "*t'o-t'ai*," or porcelain from which the "embryo" or biscuit has been removed.

Next in order is the Hsuantê period (1426-1435), and among the porcelain of this period the kind which was covered with crimson glaze, or bore designs in that color, is said to hold the highest place in the eyes of Chinese connoisseurs. Another style of decoration was "three red fish on a white ground pure as driven snow, the fish boldly outlined and red as fresh blood, of a brilliant color dazzling the eyes." Still rarer styles of decoration were three pairs of peaches in red on a white ground, and a "white ground decorated inside and outside with cloud scrolls engraved in the paste, a scroll border above colored crimson, the handle a dragon of bold design molded in high relief coiled round the top, with teeth and four claws fixed in the rim, enameled vermilion red."

During the Ch'ênghua period (1465-1487) the production of blue porcelain, bearing a blue decoration under the glaze, continued, but the supply of blue from abroad had become exhausted, and for this reason, coupled with a growing preference for ornamentation in enamel colors, this ware was inferior in color to that of the Hsuantê period. There were five more periods in this dynasty: The first was Hungchih (1485-1505), in which a light yellow color was most in vogue, although enameling in color was also employed. The second was Chêngtê (1506-1521), in which period decoration in enamel colors continued, and further supplies of the Mohammedan blue were obtained, which caused attention to be again turned to the production of porcelain ornamented with blue under the glaze. In this period also a curious kind of earthenware was made. Teapots of this ware were of a light brown or covered with a vermilion glaze. The third was Chiaching (1522-1566), during which the yellow glaze was abandoned, and decoration in enamel colors nearly died out. The old ornamentation in blue under the glaze was chiefly admired, and to the present day the "blue and white" of this period is much sought after. The last periods of this dynasty were the Lungch'ing (1567-1572) and the Wanli (1573-1619). It now had become difficult to find good clays, and this fact, combined with increasing political disorders throughout the empire, caused a marked deterioration in the quality of the ware produced, although good workmanship was sometimes effected, the most highly prized having marks on them resembling "millet grains," or a surface marked as with the pittings on orange peel.

The Ming dynasty was now at an end, and with the year 1644 the present dynasty commenced. The great factories at Chingtê-chên, which had been closed for some years, were reopened when the Manchu emperors were firmly established on the throne, during the reign of K'anghsi (1662-1722). This emperor and his two successors, Yungchêng (1723-1735) and Chienlung (1736-1795), advanced the ceramic art to the utmost degree. The ablest artists were employed, and the workmen and decorators were specially educated to a high level of proficiency. So rapid was the progress made that between 1698 and 1773, the manufacture and decoration of porcelain in China attained a degree of excellence probably never reached before or since.

Green was the predominating color for decoration during the early part of K'anghsi's reign, and hence the name *famille verte*, which was applied to this porcelain. Later, green gave way to red, and a style of half tints and broken colors with a base of carmine to pale rose was the distinguishing feature. With the addition of yellow derived from antimony, and white from arsenical acid, the variety and beauty of the decorations were greatly increased.

In 1727, after Yungchêng came to the throne, Nien Hsi-yao was made director of the imperial manufactories. His products, known as Nien porcelain, were graceful in form and of fine workmanship. They were chiefly monochromes, of blue, bright and carmine reds, céladons, and "of egg color as bright as silver." The monochrome vases became extremely fashionable, and one small vase, only eight inches high, was not long ago sold in New York for fifteen thousand dollars. After Nien Hsi-yao had had charge for fifteen years, T'angying succeeded him, and the objects made under his orders were remarkable for delicacy of workmanship, purity of form and brilliance of coloring. He is also credited with the invention of several new styles of decoration, such as the use of European blues and violets, a ground of enamel black, white flowers or designs in gold on a black ground, etc. About the same time an opaque-white vitreous ware was introduced for making small articles, such as snuff-bottles, wine-cups, etc.

When Chienlung came to the throne, there became noticeable a decided change in the style of ornamentation, due probably to the influence of foreign designs,

and especially to the importation of designs from Persia to be copied in China, or porcelain ordered from that country. It was at that time that European nobles and men of wealth conceived the idea of ordering services of porcelain from China, bearing their family arms. The plates bearing the arms of England, France, and the Netherlands, still preserved at The Hague, date from the first half of K'anghsi's reign, but the great majority are of later origin. Chienlung was succeeded by his son Chiaching (1796-1820), and all art languished under his feeble-minded rule, but under his second son, Taokuang (1821-1850), in spite of internal difficulties caused by wars with France and England, some attention was given to the ceramic art, and the porcelain made for his own use compared favorably with that manufactured under some of his more worthy predecessors, and is at the present day much sought after by Chinese connoisseurs.

The last period to be considered here included the years 1862 to 1874, when T'ungchih was the Emperor. The manufacture of porcelain was renewed, and great attention was paid to its improvement, and the same remark applies to the next reign, which began in 1875. Some of the decorations in sepia are of a high order of merit, another style which came much into favor consisting of flowers and butterflies in black and white on a pale turquois ground. But in more recent years the most marked advance has been made in the reproduction of the *famille verte* decoration—which was mentioned in alluding to the work of the first half of K'anghsi's reign—and of plum blossom on black grounds.

ITALIAN ENDURANCE OF ARCTIC COLD.

The narrative just issued by the Duke of Abruzzi, in which his Royal Highness gives his personal experiences of life and exploration in the Arctic zone, is followed by the report of Capt. Cagni, commandant of the "Stella Polare," on a sledge journey to the highest degree of latitude yet reached, and wound up by the medical "relazione" of Dr. Achille Cavalli Molinelli on the hygienic aspects of the expedition. A few excerpts from Dr. Cavalli Molinelli's report may not be unwelcome.

To begin with, Italians have always shown themselves capable of enduring, not only a very high, but also a very low temperature—the latter fact made memorable by Baron Larrey, Surgeon-General to the Emperor Napoleon's "Grande Armée" in the disastrous retreat from Moscow in 1813, when, of all the contingents, Murat's 10,000 Neapolitans were found to have suffered least, not only from the physical privations common to the whole army, but even from the cold, which was as prolonged as it was intense. This observation of the French surgeon is confirmed by Dr. Cavalli Molinelli, according to whom the health of all on board the "Stella Polare" was excellent—the only exceptions being the Duke himself and Commandant Cagni, whose scientific zeal so outran their prudence that they suffered severely from frost bite, resulting, in the commandant's case especially, in lesions affecting the hands and even costing him several fingers.

Increase of weight during the winter was observed in a number of the party, who felt greatly better than in their native Italy. Colds, from which they suffered habitually at home, they quite got rid of, although they had often to pass (without taking special precautions) from 15 or 18 degrees above zero in their tent to 35 or 40 degrees below it in the open. Dr. Cavalli Molinelli attributes this result to the absolute purity of the atmosphere without dust, and calls attention to the fact that more than one of these subjects when nearing the coast "was seized with a sudden and continuous desire to expectorate."

The rigorous limitation of fermented liquors in the dietary and the prohibition of distilled alcohol had also their invariable effect in maintaining the health of the party. Dr. Cavalli Molinelli allowed no cognac, rum, or whisky to be taken except on rare and special occasions as a condiment or as medicine. Wine was conceded only in small quantity at supper—about 120 grammes of "barolo" (a dark-red "blood-making" wine) or 60 grammes of port. The good results from this regimen were conspicuous, he adds, not only in the excellent hygienic conditions above referred to, but also in the temper of the party, alacrity and cordiality always prevailing among the subalterns. Nor was it only among the Italian nationality that these effects were seen. The Norwegian contingent, inured more or less to the ingestion of alcohol, and using beer as a constant beverage at home, were manifestly better for the abstention from these drinks, as practised on board the "Stella Polare" and on the sledge journeys.—The Lancet.

THE NAVAL WAR GAME BETWEEN THE UNITED STATES AND GERMANY.—IX.*

By Fred T. Jane.

OPERATIONS OFF KIAO CHAU.

As already related, the German fleet retired to Kiao Chau, there to be blockaded by the American vessels. This acceptance of a blockade was taken by the Americans to indicate that several German ships were so damaged at the Manila fight as to be now useless. As a matter of fact, however, this idea was only very partially correct. The "Kaiser Friedrich der Dritte" certainly needed repairs, but the main object of the Germans in allowing themselves to be blockaded was a strategical ruse. By means of it they secured a heavy initial advantage in ability to choose their own time for fighting, and to have that fight with full bunkers. As, however, the Americans were accompanied by colliers and were allowed their claim to have these fitted for coaling at sea, they too were enabled to keep their bunkers fairly full, and no ships had to be absent, as at off Santiago in the Hispano-American war. In one respect, therefore, the German side drew a blank. They were waiting at Kiao Chau till one of the "Maine" class should be absent, and for this they waited in vain. After a ten days' quietness, the Americans lying below the horizon were informed by two destroyers that were with them that the German fleet was coming out.

It came out in line ahead in the order indicated in the diagram. (In all these diagrams Kiao Chau lies to the right.) The two best ships, "Wittelsbach" and "Zaehringen," were at the head and tail of the line respectively; the weakest, the "Kaiser Friedrich III." and "Fürst Bismarck," occupied the center.

This formation of a line is good, a weak "tail" being the worst of drawbacks, since it invites attack in that quarter.

The American formation-order, from this point of view, was not so good. The ships were, however, disposed to meet a different contingency, one in which speed was the principal factor. For that reason two squadrons were formed, the first of the three homogeneous and fast ships of the "Maine" class, the second of the remaining non-homogeneous and slower ships "Alabama," "Kearsarge," "Indiana," and "Massachusetts." Should speed be urgently needed, the American fleet was, therefore, in a position to detach a strong, swift force, one that roughly represented half its total strength.

It may not be without interest at this juncture to compare the fleets by the rate values assigned to classes in the "All the World's Fighting Ships" (Munn & Co.) classification.

U. S. Fleet.

3 "Maines," Rate I at 1.0 each	= 3.0
1 "Alabama," Rate I at 1.0 each	= 1.0
1 "Kearsarge," Rate I at 1.0 each	= 1.0
2 "Indianas," Rate II at .8 each	= 1.6
	6.6

German Fleet.

2 "Wittelsbachs," Rate 1 at 1.0 each	= 2.0
5 "Kaisers," Rate II at .8 each	= 4.0
1 "Bismarck," Rate II-III at .7 each	= .7
	6.7

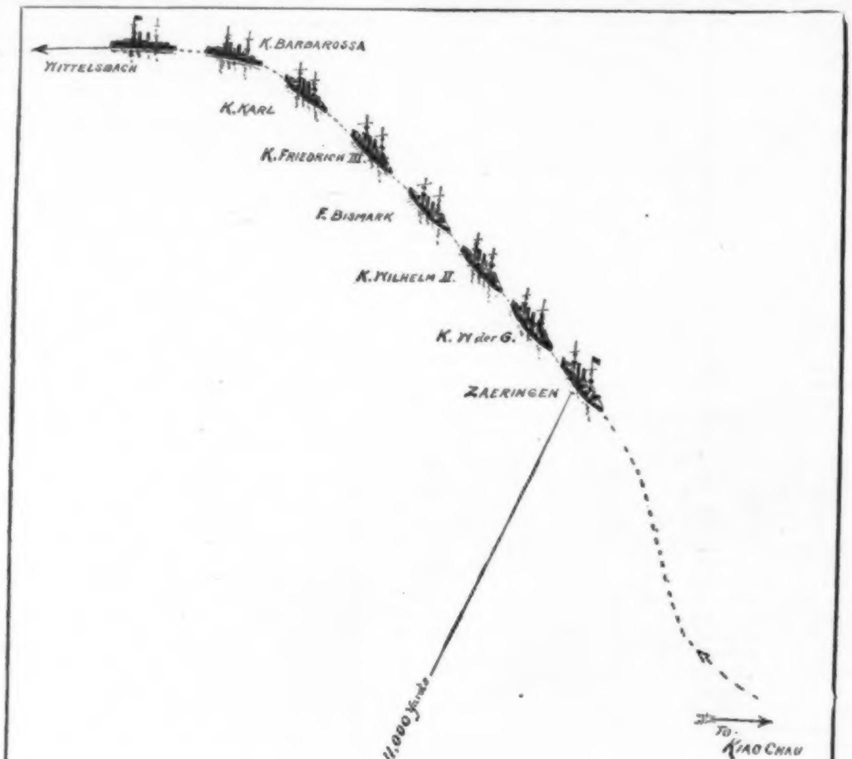
Bearing in mind that the Americans had the advantage of two destroyers with them against the German advantage of greater homogeneity of units, it may be said that the fleets were as nearly equal as might be.

It was this equality that led to the ultimate fiasco. In view of the issues at stake, neither side cared to join issue without some considerable tactical advantage at the start. An attempt to secure such an advantage led to the interesting though abortive evolutions under review. Special interest attaches to them because of the theory, now gaining ground so rapidly in most navies, that the battle of the future will be fought and won before range is reached and before a gun is fired. The fighting, by this theory, will merely determine the magnitude of the victory.

The first tactical aim of each rival admiral was to concentrate on the tail of the enemy's line, a consummation that the Germans could have stood better than the Americans. In consequence (Diagram I.) the two fleets proceeded to circle, at a range that varied from 13,000 to 11,000 yards between the nearest ships. Firing at such a distance stood to be pure waste of ammunition, and neither side attempted it.

The average German speed was considerably higher than that of the Americans, whose ships also made no attempt at top speed, doing 10½ knots while the Germans (also economical) did about 12.

Subsequently both sides increased speed somewhat,




NAVAL WAR GAME. OPERATIONS OFF KIAO CHAU—FIRST STAGE.

* Prepared especially for the Scientific American by the well-known naval expert and inventor of the naval war game; with exclusive rights in the United States and Great Britain. This series was begun in the Scientific American Supplement of December 20, 1902.

but it presently became obvious that the Germans had the power to envelop the American tail. The urgency of defeating this, with the old "Indiana" class astern, excuses the next American action—a risky complete change of formation in the face of the enemy. The leading ships slowed down, turning to starboard as they did so. The tail going full speed passed on, and so became the head.

It was a desperate maneuver, for while it was in progress ships were masking each other, and a German attack delivered while it was going on might have spelled complete disaster.

Perhaps the Germans were too far away to be able to avail themselves fully of the chance. In any case they made no attempt to do so. Instead they seized the occasion to wheel sharply (Diagram II.), their efforts seemingly concentrated on anticipating the American operation by being in a position to still threaten the tail.

The German ships were now doing full speed, and decreased the range to 9,000 yards, at which distance the "Wittelsbach" and "Indiana" exchanged fire, neither ship, however, doing any harm worth mention.

Owing to actions in which they had participated, the speed of the "Bismarck" had been reduced by three knots and that of the "Kaiser Friedrich der Dritte" by a knot and a half. The latter ship, therefore, had to shift station astern, while the "Bismarck" dropped away astern altogether. If she were left, her destruction by the "Maines" was probable, and the German admiral had therefore no option but to reduce speed. The American admiral, by going top speed, took advantage of this to place his fleet across the head of the German line.

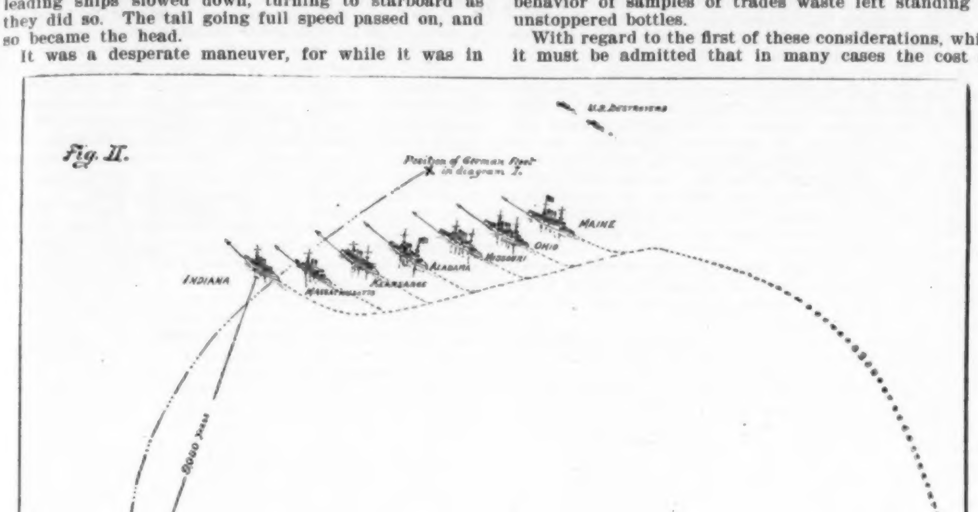
A German advance *à la* Trafalgar tactics, with the object of cutting the enemy's line in two, would have been suicidal. Realizing this, the German admiral turned all his ships to starboard together, the ships to starboard of the vice-admiral's gradually dropping astern till an echeloned line abreast, a species of quarter column, was secured.

The American fleet, proceeding in an opposite direction, was not in a position to give immediate pursuit. Had it done so, there is a strong probability that the "Maines" would have had to contend with the whole German fleet—such an eventuality was at least the German idea.

The range rapidly increased to nearly 20,000 yards. It was then manifest that the German ships were returning to Kiao Chau, to which they proceeded unpursued. That they would welcome pursuit was a little too obvious.

The reason for the retreat, as given by the German admiral, is that his original formation having been lost, he preferred to go back to harbor rather than attempt to get the "Bismarck" back in face of the enemy.

(To be continued.)



NAVAL WAR GAME. OPERATIONS OFF KIAO CHAU—SECOND STAGE.

THE BACTERIAL TREATMENT OF TRADES WASTE.*

Although much attention has been paid to the treatment of sewage on bacterial filters, little has been heard, up to the present time, concerning the treatment of trades waste in like manner.

The bare fact that in the majority of cases trades waste is likely to be strongly acid or strongly alkaline, or, worse still, charged with chemicals of an antiseptic character, has deterred many from even entertaining the idea of resort to bacterial methods of treatment in connection therewith. The author was induced to pay special attention to the subject by two causes: first, the oft-recurring statement that the sewage of a particular place was difficult to treat because of the admission to the sewers of trades waste; and second, the unexpected behavior of samples of trades waste left standing in unstoppered bottles.

With regard to the first of these considerations, while it must be admitted that in many cases the cost of sewage-treatment is increased by the influx of trades waste, it is only in rare instances that difficulty has occurred in the treatment at outfall-works, such as to call for radical modification of the methods of treatment commonly applied to domestic sewage. Cases within the author's experience are: Galvanizers' pickle at Wolverhampton, Tipton and Bilston; refuse from tanneries and glove factories at Colne and Yeovil; alkali-waste at Burnley and St. Helens; brewery-waste at Shepton Mallet and Blackburn; woolen-mill and felt-factory waste at Bradford and Nuneaton; bleachworks-waste at Burnley and Horwich. In only two of these cases has any real difficulty arisen.

Examining these kinds of waste more closely, galvanizers' pickle is common salt of iron, often used as a precipitant for ordinary sewage. It is true it is occasionally accompanied by some free acid, but this only calls for sufficient lime for neutralization in the precipitation-tanks, and the tank-effluent is then normal. At Wolverhampton, during two years' observation, the author never discovered a tank-effluent which failed to putrefy on standing, in spite of the fact that the crude sewage contained, in addition, waste and wash-liquors from ammonia and tar-distillation, shift-stop liquors, which are generally assumed to have, and probably will have, sterilizing effects in the absence of considerable dilution.

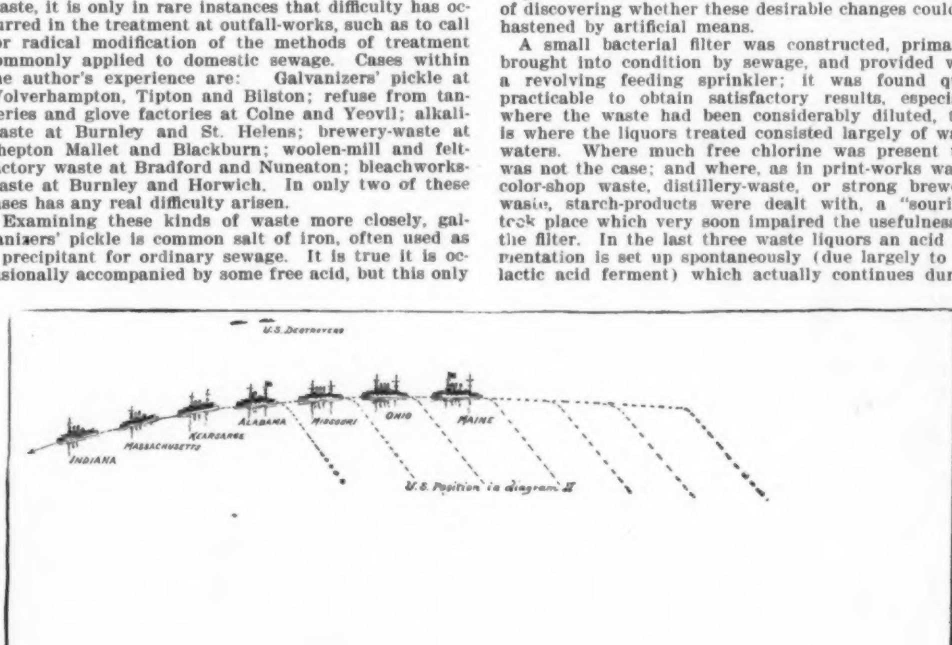
Alkali-waste may be placed in almost the same category as the Black Country waste, for when the sulphides are precipitated by ferric salts the tank-effluent is normal, and the sulphides in the sludge on exposure are almost immediately oxidized. The sewage of St. Helens has recently been treated successfully on bacterial filters. The waste from tanneries and glove-factories may be regarded simply as strong sewage, that from both Colne and Yeovil being quite amenable to bacterial treatment.

Wool-scouring liquors admitted to sewers cause difficulties of a mechanical rather than a bacterial character. Whether these are crude liquors, or the mother-liquors after recovery of grease, a certain amount of fat is included in their burden, and in the latter case some little free acid. If the acid be not neutralized by the soaps natural to the sewage, a little extra lime at the outfall soon settles this matter; but the greater objection is the fat. Quantity is here an important factor, for whereas at Nuneaton the discharges of a greasy nature from fell-mongers, hatworks and wool-scourers, are borne by the sewage to the outfall without preventing the production of a satisfactory effluent by ordinary means, at Bradford the character of the sludge formed, which is more or less an emulsion, has hitherto almost defied pressing or handling in any form. At the same time, evidence that the tank-effluent can be treated satisfactorily on bacterial filters is fairly conclusive, and there are no scientific reasons to the contrary.

Bleach-waste and brewery-waste call for special consideration. At this point it will only be said that, whereas at Burnley and at Blackburn bleach-waste and brewery-waste, respectively, are received into the sewers without giving rise to abnormal developments, at Horwich and at Shepton Mallet bleach-waste and brewery-waste, respectively, are admitted to the sewers with disadvantageous consequences, although at the latter two places the ratio of waste to sewage is much greater.

The number of trades-waste samples drawn and examined by the inspecting staff of the Ribble Joint Committee averages fifty per month. After examination many are kept as exhibits. It has been observed that the majority of these, so long as they are not acid, are subject to distinct changes on standing unstoppered. Slightly alkaline samples become neutral; then follows a deposition of coloring matter; and this is succeeded by the growth of either a mold or a green vegetation. The sample filtered from this is clear, sweet-smelling, and lightly charged with dissolved solids. Time and contact with the air being apparently the all-important elements, trials were made with the object of discovering whether these desirable changes could be hastened by artificial means.

A small bacterial filter was constructed, primarily brought into condition by sewage, and provided with a revolving feeding sprinkler; it was found quite practicable to obtain satisfactory results, especially where the waste had been considerably diluted, that is where the liquors treated consisted largely of wash-waters. Where much free chlorine was present this was not the case; and where, as in print-works waste, color-shop waste, distillery-waste, or strong brewery-waste, starch-products were dealt with, a "souring" took place which very soon impaired the usefulness of the filter. In the last three waste liquors an acid fermentation is set up spontaneously (due largely to the lactic acid ferment) which actually continues during



NAVAL WAR GAME. OPERATIONS OFF KIAO CHAU—THIRD STAGE.

* Abstract of a paper read before the Institution of Civil Engineers by Mr. William Naylor.

the sprinkling of the filter. It may of course be contended that this particular fermentation is just as much a purification as any other bacterial change, seeing that the result is the disintegration of certain objectionable constituents of the waste. But the time taken for satisfactory purification and clarification while acid fermentation is proceeding is considerable, some of the stronger liquors requiring eight, nine, and even fifteen successive filtrations.

The introduction of competitive and more active organisms—the anærobic bacteria of putrid sewage—has the effect of preventing the souring almost completely in liquors containing starch or starch-products. A trial of this was first made with ordinary starch. About 20 pounds of starch were mixed with 10 imperial gallons of hot water forming a paste. One-half of this was mixed with one imperial gallon of putrid sewage-sludge, and, after having been left standing for one day, was examined. After the expiration of five days a further sample was examined and then the mixture was passed through the filter. It may be desirable to mention here that, broadly speaking, the products of starch on inversion by acid are dextrose and dextrin; on conversion by diastase, as in brewing-operations, maltose and dextrin; and by spontaneous fermentation a mixture of these products and others, including acids more or less defined.

The dextrose or maltose produced may be measured by the amount of copper oxide reduced, but the dextrin has no reducing power. As, however, each of the products maltose, dextrose, and dextrin, has a certain optical activity, the amount of dextrin present with either of the other two products can be determined by subtracting the rotary angle due to the quantity of maltose or dextrose present (as measured by means of copper oxide) from the total rotation due to the mixture of the two. The difference in the composition of the mixture after standing one day is little more than that due to the dilution or to experimental error. At the expiration of five days, however, there is a decided change. The copper oxide reduced amounts to less than one-half, as does also the rotatory angle. This indicates decomposition of the starch to the extent of one-half or more. The remaining portion of the paste, unmixed with sewage, was unchanged in appearance and gave practically the same figures on inversion as on the first day, but smelled offensively.

After passing the mixture, five days old, slowly through the filter once, the copper oxide reduced was diminished to less than one-tenth, and the rotatory angle to less than one-half. The albuminoid ammonia—due, of course, to the added sewage—was then estimated for the first time and found to be 0.16 part per 100,000. The liquid was filtered repeatedly up to five times, the operation extending over about two working-days.

The other portion of the starch-paste had now become sour and stinking, though otherwise thick, slimy, and gray as at first, and was passed into the filter, but up to the twenty-first filtration a satisfactory effluent was not obtained, and the activity of the filter was impaired if not destroyed. The effluent was turbid, soured on standing, and gave a blue coloration with iodine, indicative of unchanged starch.

About this time, Mr. John Stanning being anxious to improve the condition of the effluent at the Leyland works of the Bleachers' Association, the author, on the success of the experiment described above, suggested treating the worst liquors only, in the same manner, and an attempt was made with kier-liquors. These amount to only about 20,000 imperial gallons daily, but as they are produced by boiling raw cloth, first with lime and afterward with soda, they are very foul and concentrated, apart from the strong alkalinity (nearly one-tenth normal). The most objectionable feature of the waste was its extreme alkalinity. But in spite of the difficulty experienced in preserving the alkalinity of exposed liquors, and knowing the derision with which practical manufacturers would receive a process of impounding, sprinkling, and filtering alkaline liquors for any purpose, and retaining the alkalinity, the trial was proceeded with.

Eight parts of kier-liquor were mixed with one part of wet sewage-sludge and were allowed to stand for one week. A reduction in alkalinity was the only noticeable change due to standing. But, after being sprinkled three times over a three-foot filter of broken clinker, previously brought into condition by sewage, the change was remarkable, the albuminoid ammonia being reduced to nearly one-quarter and the effluent becoming clear and neutral in reaction. The nitrates present were, in the author's experience, phenomenal; due, of course, to the added sewage. The advantage of standing two weeks was found not so considerable as to justify the expenditure involved in the extra tank-accommodation. It is probable that better results would be obtained for less capital expenditure, if more of the outlay was applied to the provision of larger filtering-area.

In view of these results, it was decided to install filters and to modify the tank system for the treatment of the whole volume of liquors, amounting to 500,000 imperial gallons daily; and although, as these are only now in course of construction, no results can be given, those from a similar but smaller installation at a bleach-works and calico-print works—probably the first installation of its kind—can be cited.

The works are those of Messrs. Peel, Tootal & Co., of Baxenden. In these works the processes are uniform from day to day, and consist of boiling gray cotton cloth, first with lime and afterward with soda. These boilings are followed by an acid wash, and then a chlorine bath, apart from certain intermediate and final washings. The wash-liquor, therefore, contains lime, soda, chlorine, and the various substances removed from the crude cloth (starchy sizes, china-clay, etc.), as well as adventitious dirt from the floors and workshops. Some dyeing is also done, and the waste liquors from the dye-becks also find their way to the main outfall.

For some three or four years before July, 1900, the firm had struggled with precipitation-tanks and ordinary continuous-flow filters without success. At that time proceedings were instituted under the Rivers Pollution Prevention Act, and as a result it was decided to try bacterial treatment. At the outset, the capacity of the tanks was increased so as to be equal to not less than three days' flow. The tanks are common impounding tanks provided with floating arms, and are all connected and used as one large septic tank.

The continuous overflow from the tank runs into a hopper over the revolving sprinkler, which delivers on to a filter of furnace-ashes of graduated size, the largest of which, forming the bottom layer, pass through a $2\frac{1}{2}$-inch ring, and the smallest, forming the top layer, are retained by a $\frac{1}{4}$-inch mesh. Each filter has an area of 60 square yards and a depth of 11 feet. When the plant was first put into operation, about 4 tons of old sewage-sludge was delivered into the tanks, and they were then filled with ordinary liquors. After standing until the mass became putrid, i. e., for about four days, the ordinary liquors were introduced and the filter was fed. To maintain the putridity, all the works-closets were connected with the tanks, and in case of any falling off in that respect, sewage-sludge was added from time to time. This, however, was not found necessary to any considerable extent.

As is the case with all bacterial filters provided with sprinklers, a small amount of suspended matter is delivered with the final effluent, but in this case it is intercepted by a small sand filter.

The working of the plant has been very satisfactory. The effluent is clear and colorless, in spite of the raw liquors varying from a deep purple to a chrome yellow. It is sweet, neutral, contains nitrates and little albuminoid ammonia; and the effect of the antiseptic free chlorine is nowhere observed. The filter is quite active bacterially, and treats successfully 350 gallons per square yard. A further filter is being installed.

The most noticeable feature in the working of the plant at Messrs. Peel, Tootal & Company's works, is that the free chlorine present in the crude waste does not, as might be anticipated, interfere in the least with the bacterial activity of the filter. Presumably it becomes combined in the septic tank with the products of decomposition set free in the putrid sewage. The bleach-waste discharged into the sewers at Horwich is evidently of such volume as to leave a surplus as the tanks are used at present; though it is possible that if they were used on the septic system the difficulty would disappear. At Burnley, bleach-works waste containing no inconsiderable amount of free chlorine is admitted to the sewers, and a satisfactory effluent is obtained from bacterial filters, but the tanks are of open septic type.

Brewery-waste and distillery-waste is treated with difficulty, if at all, on bacterial filters directly, owing to the formation of acids. A sample of crude beer was sprinkled twenty-three times over a bacterial filter three feet deep, the loss due to evaporation being continually made up with water; but on each successive filtration the filtrate was sour, and though a considerable change was effected in the liquor, at the conclusion it was of a dark brown color, muddy in appearance, sour and offensive. Another sample was allowed to stand for five days in contact with one-fifth of its volume of wet putrid sewage-sludge from a septic tank, and was then sprinkled over and passed through a filter. After the second filtration, both the optical activity and the reducing-power had disappeared, and the fifth filtrate was an excellent effluent showing a diminution in total solids from 3,200 parts to 200 parts per 100,000. The effluent was clear, sweet, colorless and neutral, but contained a small amount of suspended matter. Five filtrations may appear to be an excessive number, but it must be borne in mind that the strength of brewery-waste would be only about one-fifth, and that of distillery-waste about one-half to one-third of the strength of crude beer.

An average distillery may be considered to discharge about the same volume of waste liquors as an average brewery, namely 25,000 to 35,000 imperial gallons daily, and almost any method of treatment applicable to one is applicable to both.

At the Hook Norton Brewery Company's brewery, Hook Norton, Banbury, a settling-tank and continuous-flow sand-and-gravel filter was used, but with little success, during the six years ending 1898. It was then tried intermittently with no better result, and on the suggestion of the author the plant was remodeled in 1900. The flow is reduced, by eliminating all clear water, to about 12,000 imperial gallons of strong liquor per day. This is impounded in a settling-tank for not less than 24 hours in contact with putrid sludge from sewage, or 5 per cent of domestic sewage is admitted to the tank, and when the putridity has once been established, sewage-sludge is no longer necessary. The contents of this tank, which may be termed an "anti-souring" rather than a septic tank, are pumped continually by a pulsometer delivering into the hopper of the sprinkler over the filter. After being first brought into condition by means of sewage only, the filter was started on June 7, 1900. The filter is in better condition than when it was started.

The filtering-medium is coal, screened and graduated in size from about 1-inch cubes at the bottom to $\frac{1}{4}$-inch cubes at the top. The company, being well provided with steam, were prepared (under threat of legal proceedings from two sources) to pump the first filtrate on to a second filter for further purification, but this was not found necessary. The little suspended matter present after the first filtration is intercepted by shallow sand filters, and the effluent is clear, neutral, colorless, sweet, contains nitrates, and liberates albuminoid ammonia to the extent of about 0.1 part per 100,000. The diminution of dissolved oxygen after saturation, is less than 30 per cent. Similar installations are being made at the Fountains Free Brewery, Blackburn, and, in a modified form, at Messrs. Sumner's Brewery, Haigh, Wigan.

The difficulty with regard to free chlorine having been overcome in the case of bleach dye-works, Messrs. Wiggins, Teape & Co., of Chorley, Lancashire, decided in August, 1900, to try the effect of bacterial treatment on the waste from their paper mill. The effluent from the mill was fairly clear, having been settled and filtered through continuous filters of animal charcoal. Complaints, however, were made by riparian owners on the River Lostock, some distance below the works, as considerable decomposition took place, with the usual offensive emanations. By this time the sterilizing effects of the chlorine had evidently been annulled. The most objectionable constituent of the crude liquors is the organic matter from the old rags used, and the starchy and fatty sizes from the new unbleached cloth or "parings." It was decided first to try the bacterial filter with sprinklers on the ordinary tank-effluent. Fairly satisfactory results were obtained by this means, but as the effluent was turbid, probably owing to the presence of finely divided particles of china-clay, sewage was added. The installation is practically identical with that at Messrs. Peel, Tootal & Co.'s works, and the Hook Norton brewery. The results are highly satisfactory—one of them, of no little importance, being the absence of the turbidity due to the coagulating effect of the sewage. In almost all mills where esparto grass is used, much difficulty is experienced in obtaining a clear effluent, even after filtration through very fine ashes. After admixture with sewage, however, and sprinkling, the final effluent contains much less suspended matter than that from brewery-waste.

In the discussion of the paper, Dr. Samuel Rideal stated that the author had confirmed the view which he himself held, that if the proper sequence of bacterial processes was adopted, practically all kinds of organic matter would break down and give satisfactory effluents. By proper sequence he meant, not the method adopted five or six years ago, following the work of the Massachusetts Board of Health, of attempting to effect the whole decomposition in a contact-bed, but the realization of the absolute necessity of bringing about a preliminary decomposition of an anaerobic character before passing the liquid into a filter-bed where it was under oxidizing influences. With regard to the starch-paste experiments, all chemists were well aware that complex carbohydrates were capable of being broken down into carbohydrates of simpler constitution by a process of hydrolysis which did not involve any oxidation at all. But that inversion or hydrolysis required time and suitable conditions, and one of those conditions was not the presence of oxygen. It was seen clearly from the experiments in the paper that the cellulose liquids which had caused a great deal of nuisance in many districts when allowed to stand by themselves with the proper ferment, produced by mixing them with some anaerobic sewage, underwent a considerable breaking down in these simpler carbohydrates, which were then easily oxidized in the final stage. Another point brought out clearly was that the effect of the decomposing-tank or preliminary anaerobic decomposition was sometimes to augment very considerably a figure by which both engineers and chemists in the past had set great store, namely, the albuminoid ammonia. Therefore, as he had contended on previous occasions, an arbitrary standard of albuminoid ammonia must not be set up, because here was a process going on in the direction of purification, but involving in every one of the experiments an increase in the albuminoid ammonia. Another point of interest was the possibility of dealing, by bacterial action, with liquids containing chlorine. He had studied some of the electrolytic processes, and had found that chlorine had a marked sterilizing effect only when the organic matter had been practically removed by some preliminary bacterial process; and then very good sterilization could be produced. Bacterial treatment was therefore consistent with the presence of chlorine in those cases in which this absorption of free chlorine by some of the organic matter first took place. Free chlorine was also removed in another way prior to bacterial decomposition—he thought it had been so removed in some of the author's experiments—namely, in the presence of ammonia. Free ammonia re-acted with chlorine very quickly, a neutralization was effected, and the germicidal properties of the free chlorine were in this way removed. Therefore a liquid containing free ammonia as well as free chlorine quickly reached a state in which it was amenable to bacterial change.

AN INTERESTING PROBLEM IN THE CHEMISTRY OF METALS.

An interesting study of metals has been published by the French author, M. Ditte, and therein the writer propounds a very difficult and interesting query as to what becomes of the metals? As is well known, the majority of pure metals are in a very unstable condition. By the expenditure of energy other chemical elements which were originally amalgamated with the ores are liberated, leaving the pure metal behind, but these released chemical agencies are constantly awaiting the opportunity to re-enter the combination. This action deteriorates the metal, and causes its decay in the form of rust and corrosion. The question then arises, what becomes of this rust? M. Ditte asserts that the oxides are finally transformed again into ores, and ultimately collect in the earth to be dug up again at some future time. A metal when extracted from its ore is always subjected to the action of a large number of alterative forces, under which influence its weight diminishes little by little until the metal disappears altogether. Its life may be short or it may be extremely long, but it returns at last to the earth whence it came. It is to be noted that in most cases it even reassumes the form in which it was first found as an ore. Iron or tin, which we extract generally from other oxids, are destroyed by oxidization. The principal sources of copper are oxids and sulfids, and this metal disappears chiefly by oxidation or sulfuration. Silver, which we find in the form of simple or complex sulfids, is changed back into sulfid with great ease, and lead, whose principal alteration products are the sulfid and the carbonate, is found chiefly in the form of galena and ceruse. Gold and platinum, which are rarely found other than pure, and which are only slightly alterable under the most diverse influences, disappear by friction and mechanical action.

Thus the masses of metal prepared industrially are altered and disappear little by little, and their remains are scattered as dust that mingles with the other elements of the soil. Then they meet with other saline substances and with water, which dissolve and mineralize them, causing them to enter into the cycle of operations that is going on in the interior of the globe. There water circulates in the cavities of the earth's crust, and apparently they take part in the reconstitution of minerals, which in the course of centuries will form new metalliferous deposits to be exploited by the industries of a distant future.

TRADE NOTES AND RECIPES.

How to Keep Fruit.—The Journal d'Hygiene says: According to experiments of Max de Nansouty, fruit carefully wrapped in silk paper and then buried in dry sand will preserve a fresh appearance with a fresh odor or flavor, almost indefinitely. They may also be preserved in dry excelsior, but not nearly so well. In stubble or straw fruit rots very quickly, while in shavings they mildew quickly. In short wheat straw fruit often takes on a musty taste and odor, even when perfectly dry. Finally, when placed on wooden tablets and exposed to the air, most fruit decays rapidly.

Glove Cleaning Soap.—For a glove and clothes-cleaning soap try the following:

Castile soap, white, old and dry	100 parts
Water	75 parts
Tincture of quillaya	10 parts
Ether, sulphuric	10 parts
Ammonia water, FF	5 parts
Benzin, deodorized	75 parts

Melt the soap, previously finely shaved, in the water, bring to a boil and remove from the fire. Let cool down, then add the other ingredients, incorporating them thoroughly. This should be put up in collapsible tubes or tightly closed metallic boxes.—National Druggist.

To Silver Glass.—Make a silvering solution as follows: Dissolve 48 grains of silver nitrate in 1 ounce of distilled water and to the solution add ammonia water until the precipitate at first thrown down by it is nearly, but not quite, redissolved. Let stand for an hour or two, then filter, and to the filtrate add sufficient distilled water to make 12 fluid ounces.

The reducing solution is as follows: In a flask of sufficient capacity dissolve 12 grains of sodium and potassium tartrate (Rochelle salt) in 1 ounce of distilled water. Bring to a boil, and while boiling add 2 grains of silver nitrate dissolved in 1 drachm of distilled water. Let boil for 3 or 4 minutes, then remove from fire; let cool down, and after letting stand a few minutes filter through paper. To the filtrate add sufficient distilled water to make as before, 12 fluid ounces.

To use: Make the glass to be silvered *chemically clean* on the side on which the silver is to be deposited. To effect this, cleanse first, with sulphuric or nitric acid, rinse in running water and then flood with liquor potassæ. If necessary to get rid of grease repeat these processes, rinse in running water and, finally, in alcohol. Be careful not to let your fingers come in contact with the surface after cleansing, but handle the plate either with clean wooden forceps or in such manner that nothing comes in contact with the cleaned surface. To silver, equal parts of the fluids are necessary. As the deposition of the metal goes on from every direction at once, but is strongest and best at the top, smaller mirrors are silvered by suspending the glass, cleaned surface downward, over a vessel having the same superficial area as the glass set perfectly level and filled with the mixed liquid. The surface of the glass should exactly touch that of the liquid at all points, and care should be taken that no bubbles or air spaces are left between the surfaces. In warm weather all that is necessary is to place the vessel and glass where the direct sunlight (or a strong diffused light) can reach it, but in cold weather the apparatus should be kept at a temperature of from 90 deg. to 110 deg. F. The liquid at first becomes intensely black, but clears up as reduction progresses. As soon as it becomes somewhat clear the process should be stopped, the glass removed and rinsed under running water, and allowed to dry spontaneously. The silvered surface should subsequently be varnished with a strong solution of shellac into which some thickening powder (such as English red) has been stirred. While the silvering and reducing liquids are the same, larger mirrors are treated very differently.—National Druggist.

To Make Writing Paper or Postal Cards Sensitive to the Light.—To sensitize letter paper, postal cards, etc., so that they can be used for copying purposes, try the following process.

Make a thin gruel-like preparation of rice starch, and color it with any desired water-color. With this, smear or paint over the paper or card, and let dry well, then coat with a solution of potassium bichromate, 3 gm. in 50 ccm. of water, being careful not to get any of it on the reverse side of the paper or card. Use as for ordinary copying (photographic) purposes. —Photographische Rundschau.

To Transfer a Photographic Film to a New Surface.—In photographic practice it often becomes necessary, or at least desirable, to strip off the negative film, either for reproduction or other purposes.

Prepare a solution consisting of 4 parts each, of methylic alcohol and water, and 3 parts of formalin. For use, add 8 parts of this to 1 part of water. Now, with a sharp knife, cut the negative away for about 5 mm. (1.5 inch) from the edge and place the plate in as nearly a horizontal position as possible, and pour over it some of the last-named liquid, in such manner that the entire surface of the negative is moistened therewith. This is best achieved by spreading it with a strip of paper.

In the course of 2 or 3 minutes the corners of the film are carefully raised, to assure one that the gelatin is completely dissolved. If this has not occurred to the satisfaction of the operator, the liquid is allowed to remain in contact a little longer. Have ready prepared a sheet of paper somewhat larger than the negative, saturated with the formalin solution. Place this on the surface of the film and roll it down smooth with the squeegee so that the two surfaces are in contact at every point. The paper, and the film with it, may now be raised and the latter transferred to any desired surface, gelatin, celluloid, etc., when, after drying (which usually occurs in five minutes), the film is ready for use. If it be desired to transfer the film to a fresh glass plate, it should be first covered with a paper saturated as above, and then pressed to place with the roller, when the paper may be removed.—Schweizerische Photographische Zeitung.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

An Immediate Opportunity for American Cod Fishermen.—In my report dated November 5, 1902,* I called attention to the failure of the French sardine catch this year and to the consequent heavy loss to all those engaged in this important industry, of which Nantes is the center of exportation. As stated, the failure of the catch was due to the high price and to the consequent scarcity of the bait—a sort of oily dough made of the eggs and entrails of codfish—known commercially as "rogue." The failure of the catch has not only caused great loss to the French sardine packers and exporters, but has entailed such misery upon the poor fishermen of Brittany that popular subscriptions have been opened all over France to save them from want and starvation. This unfortunate condition has developed a scientific research in the direction of an artificial or manufactured rogue to take the place of the real article, which is imported principally from Norway and Sweden and to a small extent from Newfoundland. It is now claimed that Monsieur Landriene, a commissioner of marine, has discovered a substitute which will effectively satisfy the demand. This consists of a mixture of the heads, fins, and other débris of mackerel, tunny fish, and sardines cut away at the packing factories. This mixture is run through a sort of machine resembling an ordinary American sausage grinder, and the ground product, after being first saturated with strong old brine, is worked up into dough resembling in color and smell the famous Norwegian rogue. This product, Monsieur Landriene claims, is effectively preserved by the brine; it is harmless as a fish food, has a healthy odor, and dissolves almost immediately when cast into the sea, producing in the water the oily condition that is necessary to attract sardines.

Many believe this to be a satisfactory substitute for the rogue of Sweden and Norway. It is a product that can be so easily and cheaply made at any of the packing factories that the sardine fishermen need give no further thought to the grave question of bait, provided, of course, that the sardines will take to it as voraciously as they do to the bona fide article, which remains to be seen. It is certain, in any event, that until the value of the artificial rogue shall have been established, there will be the usual demand for the regulation bait, which, as I have already stated, is made from the eggs and entrails of codfish; and there is every reason why the cod fishermen of New England and elsewhere in North America might largely supply this market with the product in question. There is an annual demand for about 50,000 barrels of rogue, each barrel containing about 225 pounds, and the sardine packers are ready to buy from the first reliable purveyors who will offer a good quality of rogue at prices ranging from 50 to 60 francs ($9.65 to $11.58) per barrel. Incidentally, it may be stated that the American rogue, which has from time to time made its appearance in this market, is not so well thought of as the Norwegian rogue, for the reason that it is preserved with dry salt instead of in brine. It is held here that the roe when cut out of the cod should be at once plunged into old brine and left to soak for at least thirty days before being packed into barrels for use.

The sardine-fishing season begins here about the 1st of June, and if any of our cod fishermen think the matter worth their attention, they should open negotiations with the packers and other buyers here as soon as possible. If it would facilitate the matter in any way for our exporters, I should be glad to transmit any propositions they may have to make to some of the leading packers of this consular district. The customs duty in France on rogue (unless coming from an English port), with all charges, amounts to a little less than 1 franc (19.3 cents) a barrel.—Benj. H. Ridgely, Consul at Nantes.

American Automobiles in Malta.—I have recently received applications from parties here for information with regard to the advantages of the American automobile. There are already several in use, and correspondence is now being carried on between probable purchasers and American makers. One gentleman recently went to England and, after looking at the various makes of machines there, ordered one of American origin, which is giving good satisfaction. This machine is of the steam variety, being the only one of its kind here. The others are operated by gasoline. One firm desires to secure large vans for delivery of goods. No fault is found with gasoline machines except that it is somewhat difficult at times to procure gasoline, on account of local laws. It is imported from New York and other places, but the supply is apt to be limited.

American manufacturers of automobiles should bear in mind that Malta does not possess, as a rule, long, level stretches of road. There are many steep hills—some of them having a grade of 1 in 9. The machine should be much more powerful than is the rule in the United States. Another thing to be remembered is that, in giving price, the manufacturer must quote f. o. b. New York; otherwise, the inquirer will not know what his machine is going to cost him. People here know nothing about distances or freight rates between ports of shipment and our interior cities. Several negotiations have failed because the dealer in the United States insisted upon quoting prices f. o. b. Chicago or other place of export. When possible, it is even better to give prices c. i. f. Malta. In other words, when the buyer at Malta writes for terms, he should be given information which will enable him to figure exactly what the machine will cost him, landed here. If information as to the cubic measurement of the machine as crated or boxed for shipment can be given, it will add to the satisfaction of the buyer. Some time ago, an American carriage manufactured in one of our interior cities was sold here, and, to my own knowledge, one of the greatest points considered was the completeness of the information given in the catalogue. I provided other catalogues, which were prepared in attractive style and showed desirable goods, but information as to terms, etc., was very meager and they were not considered. It must be remembered that transportation from New York to Malta is now ample by way of a direct line of steamers. My assortment of automobile catalogues is somewhat limited, and I should be pleased to receive such as manufacturers may see fit to send me.—John H. Grout, Consul at Valletta.

*Advance Sheets No. 1514 (December 8, 1902).

American Flour and Lard in Malta.—Flour.—The demand for American flour and lard is increasing here, especially for the former. A year ago, I proved by statistics that there was a growing and permanent demand for flour, and predicted that 1902 would show a still further increase. That prediction has been fully borne out. Without doubt, this demand is due in a great measure to the fact that Malta now has direct communication with the United States. With the regular and frequent sailings in force, this year will show a still greater increase in Malta's imports of American goods. The following table of statistics for the years 1897-1902 tells the story, and one has but to consult it to see not only what we are doing, but also the increase or decrease of our rivals:

IMPORTS OF FLOUR INTO MALTA.

Place of export.	1897	1898	1899	1900	1901	1902
	Bags.	Bags.	Bags.	Bags.	Bags.	Bags.
New York	......	....	2,256	39,586	37,047	65,270
Liverpool	17,553	54,111	168,418	185,60[illegible]	187,346	158,345
Marseilles	16,268	10,037	15,181	26,077	8,251	7,799
London	2,165	8,240	8,855	2,183	10,575	10,037
Newcastle-on Tyne	....	....	....	....	....	2,200
Hamburg	....	....	....	....	....	1,147
Syracuse	27	760	1,765	1,596	5,544	500
Lisbon	....	....	....	....	12,862	....
Manchester	10,89	26,206	....	....	....	....
Trieste	2 8	1,742	1,40.	637	1,373	....
Total	47,180	96,19	192,970	235,679	262,993	245,296

From the above table, it will be seen that the United States supplied, during the year 1902, 65,270 bags, or 28,223 bags more than in the previous year. These figures, however, represent only the quantity arriving by steamers of the direct line. Much of the flour imported from Liverpool, London, and other ports (to which credit of origin is given) was really of American production, inasmuch as those ports were either used as places of transshipment or the flour was taken from stocks of American flour located there and shipped here on order. If it were possible to obtain the true amounts, I feel confident that the figures for the United States would be vastly larger. Our closest competitor, as will be seen, is England. The figures given for her contribution are decreasing. The total demand for the year 1902 was a shade smaller than for the previous year.

I cannot too forcibly call attention of our merchants to the advisability of sending goods here by the direct line. Vessels coming direct from the United States, as a rule, bring only American goods, while those bringing our goods from ports of transshipment are apt to bring an overwhelming percentage of products of other countries. This is a matter to be considered in the interest of increasing the demand for general lines of our goods, outside of the questions of delay, loss in rehandling, and freight charges. Merchants here understand our methods and requirements as regards terms of payment.

Lard.—In the matter of lard, I would say that Malta uses it extensively. No statistics are at present available to enable me to give the sources. During the year 1902, 16,117 buckets and 829 barrels were landed; 5,706 buckets came by the direct line from New York and were assuredly American. Of the 10,411 buckets remaining, it is safe to say that a very large proportion was American, coming from English ports by transshipment. Two-thirds of the vessels bringing lard to Malta were from English ports. From an investigation recently made in this line, I am convinced that the figures for next year will show a decided increase in the sale of lard direct from the United States. Our lard enjoys a prominence and popularity hardly reached by similar goods from other countries.—John H. Grout, Consul at Valletta.

Anthracite Coal in British Columbia.—Consul L. E. Dudley, of Vancouver, January 14, 1903, writes:

It is reported, upon reliable authority, that anthracite coal has been discovered at Cumberland, on Vancouver Island, upon the property of the Union Coal Mines Company, which is the largest shipper of coal from the western portion of this province. It is said that this anthracite coal has 80 per cent. fixed carbon.

In a later report, the consul notes that the coal field is estimated to cover 1,000 acres. The anthracite merges as it gains depth into a bituminous coal. Work on the seam is being pushed, and it is thought that coal will be shipped by next fall.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1566. February 9.—Marseilles Oil and Seed Trade of 1902—Sugar Crop in Santa Clara, Cuba—Newspapers in German Colonies—Reduction of Taxes in Colombia.

No. 1567. February 10.—*New Cotton Exchange at Bremen—*Currency Changes in Siam—*Proposed Currency Changes in the Straits Settlements—*Proposed Currency Changes in Indo-China—*Tender for Rails in Siam—*Architectural Contest in Greece—*Anthracite Coal in British Columbia—*German Chamber of Commerce in Tsi-tau.

No. 1568. February 11.—*An Immediate Opportunity for American Cod Fishermen—The Nile Reservoir—Production of Zinc by Electricity in Sweden—New Stage-coach Line in Honduras—Combination of Swedish Lumber Companies—Vote on New Swiss Tariff.

No. 1569. February 12.—Electric-power Distribution in Great Britain.

No. 1570. February 13.—*American Automobiles in Malta—*American Flour and Lard in Malta—Sugar Production in Spain—Production of Colored Cocoons—Mining Concessions in Nicaragua—New German Cable Steamer.

No. 1571. February 14.—Agriculture in Honduras—Brazilian Revenue Bill for 1903—German Exports in Morocco—Austro-Hungarian Commerce in 1902—Paper Suitable for Bills in Colombia—Export Duties of Colombia.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

Sympathetic Ink.—Mr. C. L. Seal, Wilmington, Del., informs us that common sulphuric acid well diluted with water, makes a good sympathetic ink. He sends the following formula for a "lover's ink" that he puts up and sells to his "spooning" trade:

Sulphuric acid	1 drachm
Syrup of acacia, U. S. P.	½ drachm
Distilled water	3 ounces

Mix. Developed by heat.

Acid-proof Cement.—An acid-proof cement, or application for wood, metals, etc., is, according to the Pharmaceutische Centralhalle, as follows:

Powdered asbestos	2 parts
Ground baryta	1 part
Sodium waterglass solution	2 parts

Mix.

To withstand hot nitric acid the following is used:

Sodium waterglass solution	2 parts
Sand	1 part
Asbestos	1 part

Mix.

Furniture Polish.—We print below some recipes from the Druggists' Circular for preparations with which to re-polish furniture:

I.

Shellac	4 parts
Alcohol	32 parts
Oil of turpentine	16 parts
Linseed oil, boiled	32 parts
Ammonia water	4 parts

Dissolve the shellac in the alcohol; dissolve, in a separate vessel, the linseed oil in the turpentine and mix the two solutions, adding them slowly with continuous agitation; then add the ammonia water and mix by agitation until thoroughly homogeneous.

II.

Mix one part of old boiled linseed oil with 2 parts of an alcoholic solution of shellac. Agitate each time before using, and apply in small quantities, rubbing vigorously until the polish is attained.

III.

White wax	2,500 parts
Water	4,500 parts
Potassium carbonate	25 parts
Oil of turpentine	4,000 parts

Boil the wax in 1,500 parts of the water, carrying the potassium carbonate, until the wax is saponified. Add sufficient water to replace that lost by evaporation and stir till cold and add, little by little, under constant agitation the oil of turpentine, and continue to stir until a complete emulsion is obtained. When this occurs add the remainder (3,000 parts) of the water all at once and stir in. In case the mixture is incomplete add a little more oil of turpentine.

To use the cream, smear a little of it on a thin soft rag and with this go over the furniture, then polish with a woolen cloth, or bit of flannel. The cream answers equally well for leather upholstering, imitation leather, leather cloth, marble, etc.

IV.

Paraffine wax	7 ounces
Petroleum jelly	2 ounces
Solution of potassa	5 drachms
Yellow wax	3 ounces
Turpentine	12 ounces

Place the first four ingredients in a vessel and melt with gentle heat; allow the mixture to cool and then add the turpentine.

Wax Polish for Hard Wood.—We are told that in finishing hard wood with a wax polish the wood is first coated with a "filler," which is omitted in the case of soft wood. This seems to be reversing the natural procedure, the softer wood being more porous, but our information comes from an authoritative source.

The filler is made from some hard substance, very finely ground; sand is used by some manufacturers.

The polish is the same as for soft wood. Recipes for such polishes are numerous. The simplest method of applying wax is by a heated iron, scraping off the surplus and then rubbing with a cloth. It is evident that this method is especially laborious; and for that reason solution of the wax is desirable. It may be dissolved rather freely in turpentine spirit, and is said to be soluble also in kerosene oil.

Mixtures for polishing wood which contain wax may be made as follows:

I.

Stearin	100 parts.
Yellow wax	25 parts.
Caustic potash	60 parts.
Yellow laundry soap	10 parts.
Water, a sufficient quantity.	

Heat together until a homogeneous mixture is formed.

II.

Yellow wax	25 parts.
Yellow laundry soap	6 parts.
Glue	12 parts.
Soda ash	25 parts.
Water, a sufficient quantity.	

Dissolve the soda in 400 parts of water, add the wax, and boil down to 250 parts, then add the soap. Dissolve the glue in 100 parts of hot water, and mix the whole with the saponified wax.—Drug. Circ. and Chem. Gaz.

A New Cement for Glass.—The Süddeutsche Apotheker Zeitung gives the following: A mixture of traumaticin, a solution of caoutchouc in chloroform, and a concentrated solution of water-glass makes a capital cement for uniting articles of glass. Not only is the joint very strong, but it is transparent. Neither changes of temperature nor moisture affect the cement.

THE

Scientific American Supplement

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.

1903.

ment

ar.

rs in any
dollars

from the
l. Price,

can like-
l yearly,
or $3.50

c AMERI-
PLEMENT,

ents and

w York,

PAGE
aste... 22713
ry of
...... 22714
MER. 22710
...... 22708
spon-
...... 22708
uls... 22715
...... 22709
rmy.
...... 22708
...... 22708
Chil-
...... 22708
...... 22712
Tank
...... 22702
gs.—
...... 22704
...... 22703
...... 22707
...... 22716
... 22715
the
llus-
...... 22713
a.—
...... 22711
five
...... 22706

USE,

d.
compre-
practical
olmaker

intricate
bed in a
echanics
and use
articles

structed
n. while
of the
in the
, which
ed arti-
"Ame-
his own

s book;
as been
ions of
t them
sheet-

n, die-

York.

gue

n-
is
is
e,
he
ue
he
in
i-

York,

S!

ation
mine
s for

fifty
s for
and
ited
Co.
for
n In-
done

rma-
rade
nts,

ving
s of